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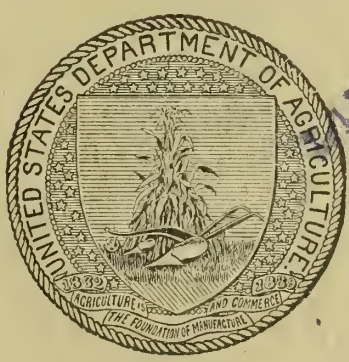
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OFFICE OF EXPERIMENT STATIONS—BULLETIN NO. 178.
A. C. TRUE, Director.

COURSE IN FRUIT GROWING FOR MOVABLE SCHOOLS OF AGRICULTURE.

BY
SAMUEL B. GREEN, B. S.,
PROFESSOR OF HORTICULTURE, MINNESOTA COLLEGE OF AGRICULTURE.



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U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN NO. 178.

A. C. TRUE, Director.

COURSE IN FRUIT GROWING

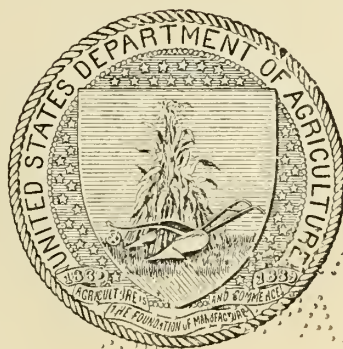
FOR

MOVABLE SCHOOLS OF AGRICULTURE.

BY

SAMUEL B. GREEN, B. S.,

PROFESSOR OF HORTICULTURE, MINNESOTA COLLEGE OF AGRICULTURE.



WASHINGTON:

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1907.

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LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., November 10, 1906.

SIR: I have the honor to submit and to recommend for publication as Bulletin 178 of this Office a Course of Instruction in Fruit Growing for Movable Schools of Agriculture, prepared by Samuel B. Green, B. S., professor of horticulture, Minnesota College of Agriculture. The intent of the projected series of courses, of which this is the second, is to give more extended and specific instruction in agriculture outside of regularly organized schools than is now being given in the farmers' institutes of the country. The value of such instruction has been clearly demonstrated in many foreign countries and there seems to be a real and growing need for it in the United States, especially in those States where farmers' institutes have been longest in operation.

Fruit growing, although one of the most important branches of our agriculture, has not had that careful attention on the part of the ordinary farmer that the value of fruit as a farm crop justifies. This has been due largely to a lack of appreciation on the part of the farmer of the possibilities of this crop as a source of income and for home use and to ignorance of the methods by which fruit culturists have succeeded.

It is hoped that the course herewith submitted will be of direct practical value by placing within the reach of the ordinary farmer opportunity to study the subject of fruit growing under the teaching of an expert with a view to his making it a remunerative feature of his system of general farming, and that it may also enable others who wish to specialize in fruit growing to select suitable varieties, cultivate, fertilize, prune, and care for the trees properly, and at the same time utilize for the purpose cheap or waste land.

Respectfully,

A. C. TRUE, *Director.*

Hon. JAMES WILSON,
Secretary of Agriculture.

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PREFATORY NOTE.

This course of instruction in fruit growing by Samuel B. Green, B. S., professor of horticulture in the Minnesota Agricultural College, St. Anthony Park, Minn., is one of a series proposed to be issued by the Office of Experiment Stations upon various agricultural subjects for use by farmers' institute workers in giving instruction in movable schools of agriculture. The course, as outlined, consists of fifteen lectures accompanied by an equal number of practice exercises. Such a course is necessarily limited in scope and covers the subject of fruit growing only in a general way. Some topics are omitted and others are treated suggestively. The references given constitute a course of reading on fruit growing which will enable the student to greatly extend his knowledge of this subject outside the movable school if he desires to do so.

The plan of organization of the movable school contemplates the formation, in various centers, of classes consisting of not less than eight nor more than fifteen persons interested in fruit culture. The course is arranged to extend over fifteen days, there being a lecture and a practicum for each day. The teacher is expected to devote such time as he may have from his class work to visiting his scholars with a view to giving advice respecting improvements that it may be possible and advisable to make in the fruit garden, orchard, or vineyard at their homes.

Each lecture is intended to occupy about one hour in its delivery. The students are not required to take notes, but at the close of the lecture a syllabus embracing the points considered, and containing references to authorities which the student is expected to consult before the practice exercise is taken up, will be handed to each member of the class.

The practicums will occupy the greatest portion of the time given to instruction, and will, for the most part, be conducted in nurseries, gardens, orchards, and vineyards in order that the scholars may observe and take part in the actual operations of fruit growing, as these operations are conducted in a commercial way.

JOHN HAMILTON,
Farmers' Institute Specialist.

COURSE IN FRUIT GROWING FOR MOVABLE SCHOOLS OF AGRICULTURE.

GENERAL SUGGESTIONS TO TEACHERS.

The lecturer should endeavor to impress principles rather than be content with the presentation of mere facts. In his practice exercises he should aim to demonstrate the important points of the lecture in a way that will make the subject clear and fix the truths taught firmly in the minds of his students. Success in teaching depends so much upon the individuality of the instructor as to make it impossible to prepare any outline that can be followed to advantage by all without modification. It will always be necessary for the teacher to adapt the lectures to the local conditions that exist and to the requirements of his scholars.

As a rule, lectures of the character here outlined are most satisfactory when they take up a subject from the standpoint of the beginner and do not rely too much upon the student's previous preparation. Have material illustrating the subject before the class while the lecture is in progress, and refer to it as frequently as possible. While it is well to call out the experiences of the members of the class, care must be taken at the same time to hold the discussion down to the point and not to digress very far from the central thought of the lecture.

The practice exercises are a most important feature of this course. In conducting these exercises it is essential that the teacher place as much of the execution upon the students as possible. By so doing interest will be intensified and the truths impressed which the course seeks to develop. The best teachers of laboratory or practice exercises are those who require their students to do the work, and devote their own time to guiding and directing.

Whenever possible, hold the practice exercises in the field and have them illustrate as far as possible something of general interest to the community. Work given in this way will attract interest and impress the students, while that which is given without special bearing on local conditions is too apt to lack point and be forgotten.

In making up the list of material needed for the lectures as outlined in this course no prices have been fixed for such items as plants growing in place, soils, etc. Material of this character can usually be obtained by the lecturer without expense.

It is not essential that the course of lectures here presented be given in the precise order in which they are arranged. This may be varied as circumstances seem to require.

The numbers in the text in parentheses refer to corresponding numbers in the list of books of reference in the Appendix.

SYLLABUS OF A COURSE OF LECTURES ON FRUIT GROWING.

FIRST LECTURE—FACTORS THAT MAKE UP A GOOD FRUIT-GROWING SECTION.

ACCESSIBILITY.

By accessibility is meant railroad and other communication, and not only nearness to market but the possibility of getting suitable transportation service at a reasonable rate. Water communication is often better than rail, especially for kinds of fruits that are easily injured by rough handling. Two or more competing lines of communication generally tend to give the shipper better service than where one road has the monopoly. While accessibility is of first importance it will not entirely take the place of suitable soil conditions, although it does sometimes make profitable the use of an inferior soil. Good wagon roads render it possible to get to the railroad station or to market quickly with large loads of produce in good condition. This is a very important consideration in the profitable development of any fruit section.

If the location is so far from the consumer that the produce must be shipped by a common carrier, it is important that fruit enough be grown in that section to make the business of handling and shipping it of sufficient importance to command special attention from the carrier and from buyers; in short, to make it a place where buyers will go for fruit. In starting fruit growing in a new place, especially where remote from market, the pioneers are often under the disadvantage of not having enough of their product to make it worth while to ship it. This difficulty can be overcome by starting the industry on a scale large enough to insure that shipments can be made in carload lots.

SOILS.

The only safe way to determine the value of a soil for a particular fruit is by actual trial. So many factors enter into the determination of the character of a good fruit soil that it is easy to be mistaken in judging of its adaptability for fruit, and yet the best fruit soils have

many points in common. There is hardly a soil that will not be found adapted to some class of fruits if the conditions as to drainage, exposure, and fertility are favorable. For instance, the pear prefers a rather heavy clay soil, the peach and cherry quite open and porous soils. The strawberry and blackberry will often do well on soil too sandy for other fruits. The currant and gooseberry prefer an open clay loam, but will adapt themselves to almost any location. Then there are locations so wondrously adapted to special fruits that it seems impossible to raise them in equal perfection elsewhere. Such are the lands adapted to the Albemarle Pippin in Virginia.

However, as J. A. Bonsteel, of the Bureau of Soils of this Department, says:

The great variety of fruits grown within the limits of the United States and the wide range in requirements for both soil and climate exhibited by the different varieties of the various species of fruit-producing plants render the characterization of any particular soil or of any class or group of soils as special fruit soils impossible.

In general it may be stated that all soils to be well adapted to the production of the majority of deciduous tree fruits must be characterized by good natural drainage; by level or rolling topography, not precipitous; by a considerable depth of surface soil and subsoil and by relative freedom from large stone or bowlders which might interfere with cultivation. When these inherent properties are present there are necessary also certain conditions of protection or exposure, of altitude and latitude, and of accessibility in order to render advisable the selection of any particular field for extended fruit culture.

The investigations of the Bureau of Soils, while not particularly directed to the study of fruit soils, have shown that the ideal soil for the production of a particular class of tree fruits, as apples, peaches, pears, cherries, or plums, varies in different sections of the country. Thus the typical apple soils of New England, New York, the Appalachian belt, the Piedmont section, the prairie region of central Illinois, the Ozark belt of Missouri and Arkansas possess in common the characteristics of adequate soil drainage, reasonable porosity, and sufficient ability to maintain moisture to insure against damage from drought. In origin, in altitude, in texture, and in topographic distribution they not only differ markedly, but there is every indication that different varieties of apples in the same general fruit region are not all equally suited to the same type of soils.

A review of the general characteristics of soils upon which tree fruits are produced in some of the best-known fruit districts, as revealed by the surveys of the Bureau of Soils, shows that orchard fruits in general require good natural drainage, a fairly friable soil and subsoil, and a sufficiently loamy soil or subsoil to retain a good moisture content. It is also apparent that neither hardpan nor underlying rock should exist at shallow depths to prevent free root development and proper drainage. It is also evident that different varieties of apples, of peaches, or of other tree fruits are adapted to somewhat different types and classes of soils, and particularly that with variations in climate, topography, and other features of environment the type of soil suited to a particular variety of a particular fruit may, in fact must, vary between different regions. Generalizations from limited areas can not be safely extended to other regions where the soils are not only derived from different parent materials but have been formed by different processes and lie under different conditions of climate, exposure, topography, and drainage. There should also be observed the fact that in a single class of fruit, and strawberries form a notable example, proper selection of varieties will insure the securing of at least one or more varieties adapted to the soil existing

on a given farm under ascertained climatic conditions. It is thus not a question of strawberry soils but one of a soil suited to produce a definite variety under fixed surrounding conditions. (References Nos. 36 and 67.)

TOPOGRAPHY.

By the topography of a country we mean its surface features. A rolling country gives good water drainage. This is of first importance, for our cultivated fruits, with the exception of the cranberry, are injured by a surplus of water. Such a country also affords more elevations where there is comparative immunity from frosts. For these reasons, good fruit growing sections are generally found where the land is hilly or rolling. But when near large water areas so that there is secured comparative protection from frosts and when sufficiently elevated to secure good drainage, land that is quite flat may sometimes prove good fruit land.

BUSINESS ASPECT.

Fruit growing as a business.—Success in any business is largely a matter of individual capability, and success in fruit growing likewise depends much on the capacity of the individual and upon his adaptability. The demand for fruit is increasing. The consumption of fresh fruits is now greater per capita than it was a few years ago. With the introduction of improved methods of storing and shipping, fresh fruit is destined to play a more important part in the diet of every American. Comparatively few years ago fresh fruit was regarded as a luxury, now it is regarded as a necessity, both for nourishment and for its hygienic value.

Overproduction of fruit.—Occasionally there is an overproduction of fruit, but it is usually of inferior quality. It rarely occurs that there is an overproduction of choice fruit. One great difficulty with which the fruit grower has to contend is in the methods of fruit distribution. Because of lack of system in this respect consumers are often unable to get the kind and quality of fruit they want, although there may be an abundance in the country. The tendency of the market is in the direction of cheaper fruit, while at the same time there is a growing discrimination in taste as respects its quality and appearance. The number of consumers who are willing and able to pay a fair price for a superior grade is fast increasing, and as population and wealth increases this discrimination in favor of the best will become even more pronounced than it is to-day. Those fruits are most stable in price that can be readily used for canning or drying, since when low in price the surplus may be readily disposed of to the local factory.

The successful fruit grower must be well informed respecting the principles that underlie the growing of fruit, that he may be able

to solve the many problems that are sure to arise in the course of his experience. It is important that he know not only how to grow fruit, but he must also know how to market it. In other words, he must be a good business man. Some of the most successful fruit growers and horticulturists have been men who were not reared to the work, but have taken it up late in life and have succeeded largely because of their business ability. It is not to be inferred from this that farmers' sons do not make good farmers, but that they often fail to get the most out of their farms owing to their lack of business training. The fruit industry requires for its successful promotion men of ready resources and accurate knowledge who can quickly comprehend and adapt themselves to varying conditions. (References No. 29, pp. 204-211, or No. 14, pp. 27-36.)

Choice of locations.—Most persons who are making a speciality of fruit growing and many farmers who contemplate changing from general cropping to fruit growing are so held by social ties, land incumbrances, and in other ways that they can not easily change their location. The matter of location is for them a settled question. If they are to engage in fruit growing at all, it must be in their present location and surroundings. To them it is a question of crop selection, crop location, and methods of management best suited to their conditions. If, as they are situated, fruit growing can not be made to pay, they had better devote their land to other purposes.

On the other hand, there is a small class of people who wish to grow fruit who are free to change their location. For such it is a good plan to visit some successful fruit sections and thoroughly study their conditions and probable future before locating permanently. In making such a study it is well to take plenty of time before finally concluding to locate, as there are many factors to be considered. It is usually unwise for a grower to change from a line of fruit with whose production he is thoroughly acquainted to one that is unfamiliar. Occasionally it may be desirable or even necessary to make such a change, but in any case it should be made with the greatest caution. The successful apple grower of Missouri may become a successful orange grower in California after he has had experience, but he will have much to learn before he can do so. The man who is starting anew in the growing of fruit of any kind should start in a small way and not risk too much on a single venture.

KINDS OF FRUIT CULTIVATED IN THE UNITED STATES.

The kinds of fruit cultivated in the United States embrace nearly all known varieties. For list of cultivated fruits properly classified see reference No. 14, pages 2-7. For the nineteen fruit districts of the United States see reference No. 59. For supplementary reading see reference No. 14, pages 7-27.

EXPERIMENT AND PRACTICE WORK, FIRST LECTURE.

I. Soils.

Material needed.—Samples of soils, 1 quart each of loess loam, heavy clay loam, heavy sandy loam, light sandy loam, gravelly loam, broken limestone, muck, all air dry. These should be kept in 1-quart Mason jars for greatest convenience. One 12-pound scale; two dozen sheets of heavy express paper 2 feet square.

Exercise.—Pour the soil samples out of the bottles, each on a separate sheet of paper. Weigh them separately and keep a record of the weight. Make a hollow in each sample and add one-half pint of water. Mix well and continue to add water until the soil will absorb no more. Weigh the samples and note the amount of water absorbed by each. This is not an accurate test of the water-holding capacity of different soils, but serves to indicate approximately their characteristics in this respect.

II. Capillarity of Soils.

Material needed.—Three glass tubes 2 inches in diameter and 18 inches long; two quarts each of fine clay, fine sand, coarse gravel, and black garden loam, all air dry; four pieces of cheese cloth, each 8 inches square; one common baking pan 2 inches deep.

Exercise.—Cover one end of each tube with cheese cloth, tying it securely near the end so that when the tube is filled with soil the cloth will not be displaced. Fill tubes each with separate samples of soil, packing it in firmly. Set the end covered with cheese cloth in a pan containing about one-half inch of water. Note the time required for the soil to become wet by the passage upward of the water. This property of a soil is a very important factor in determining its agricultural value. This operation should be continued for several days, as it will require that length of time for the water to reach its maximum height.

III. Fruit Districts of America.

Material needed.—Enough maps of North America and of the State in which the exercise is given so that each student may have one of each. These should be mere outline maps printed on plain unglazed paper that can be readily marked with a lead pencil.

Exercise.—On the maps have the students trace the boundaries of the different fruit districts as given in reference No. 59. Note the fruits that grow in each district. Prepare written descriptions of the elevations, soil peculiarities, and rainfall of several of the important fruit districts. Enter these data on the map in the appropriate areas. On the map of the State in which the student resides have him mark the areas especially adapted to the various fruits and indicate their characteristics.

IV. Orchard Sites.

Locate orchard sites, considering suitability of soil, elevation, expense, soil drainage, air drainage, accessibility to markets, adaptability to variety of fruits.

SECOND LECTURE—CULTIVATION AND COVER CROPS.

GENERAL STATEMENT.

In a state of nature where trees do well they generally have the surface soil about their roots covered with a loose accumulation of vegetable mold which shields from the sun and wind, while the deeper soil is filled with roots more or less decayed tending to keep the subsoil porous. This covering protects the soil from drying out and furnishes the conditions aimed at in cultivation. Treatment in imitation of forest conditions has been unsatisfactory in that the shade precludes the light and air necessary for the production of perfect fruit. It also renders inconvenient access to the trees for gathering the fruit and for applying insecticides and fungicides to protect from noxious insects and diseases.

IMPLEMENTS FOR CULTIVATION.

For the first few seasons after the trees are set out and where cover crops are grown in the orchard fairly deep plowing and a plow heavy enough to completely turn under all the material accumulated on the surface will be needed. If there is but little matter to turn under, a lighter plow or even some of the better types of cultivators or harrows will suffice. On the heavier clay soils the first two or three cultivations in spring, when the soil is lumpy, should be done with rather heavy implements like the spring-tooth or other harrows, but later in the season when the object of cultivation is chiefly to conserve moisture by means of a dust mulch the lighter spike-tooth drags will more nearly meet the requirements. The present system of heading orchard trees low practically prevents the use of any tools for cultivation having high wheels or handles. The singletrees should be short and the ends covered with cloth to prevent barking the trees, or a traceless harness used instead. If the limbs are low, some one of the extension harrows now in use will prove very useful. Or if one has rather long whiffletrees any of the usual cultivators can be separated in halves sufficiently far apart to reach under the trees. The harnesses should be free from metal projections and there should be no high tops to the hames. Harnesses are now made which draw by a single chain between the horses and without whiffletrees.

EFFECT OF PROPER CULTIVATION.

(a) To give the plants we desire to grow all the light, air, and moisture that they can use by keeping out of their way all competitors in

the shape of weeds. (b) The most common source of injury to our crops comes from drought. Soil that is compact will transmit water upward by capillary attraction much more readily than soil that is somewhat loose, and very loose dry soil loses scarcely any water in this way. This is the chief reason, and by many regarded as the only reason, for cultivation. The loose top soil acting as a mulch prevents the evaporation of water from the compact earth below. The extent of this protection is shown in the following table:

Effect of cultivation on moisture content of soil.

Soil depth.	Water in field.	
	With shallow surface cultivation.	Without shallow surface cultivation.
	<i>Per cent.</i>	<i>Per cent.</i>
3 to 9 inches.....	14. 21	8. 02
9 to 15 inches.....	17. 21	12. 38

(Reference No. 34, pp. 31-45.)

(c) The working of soils opens them up so that the air can get in and assist in rendering available the plant food locked up in them in an insoluble form. This is an important function of tillage. The soil is a great laboratory in which many complex changes are continually taking place. Its continued cultivation sometimes affects it injuriously by oxidizing all the humus (decayed organic matter) and leaving it in a condition in which it washes badly and will not hold moisture. A good illustration of this change is in the fact that newly cleared land planted to orchard trees will seldom wash badly until the decayed organic matter in it has become so thoroughly oxidized that it no longer holds the soil together. After this organic matter has disappeared, clay soils lose their loose porous texture and become hard and destitute of moisture.

GROWING TREES IN SOD.

This practice is not to be generally recommended, and yet there are sections where apples do exceedingly well when grown in sod or when mulched. In other sections, as on the high steep clay bluffs along the Mississippi River, trees may be grown to great perfection by spading up the soil about them for a distance of 3 or 4 feet from the trunk each spring, and later in the season the grass and weeds mowed and put around the trees. However, such locations are exceptional, and the great truth remains that orchards which are kept in sod are seldom profitable. When orchards are in a stiff sod, the rain water is often prevented from soaking into the land. An old sod on a steep hillside sheds water readily. The grass roots also take up

large amounts of water from the soil. Therefore in sections liable to drought, the formation of a close sod in the orchard should be prevented as much as possible.

MULCHING.

Growing trees and other plants through the use of mulching may sometimes be successfully practiced under certain conditions.

(a) Where there is an abundance of good mulching material. There is a great difference in the value of different kinds of mulch. A covering of coarse weeds for instance may afford but little protection.

(b) Where the soil is well worked in the spring before the mulch is applied.

(c) Mulch may often be used to advantage close to the trees where the soil near them is not easily cultivated.

(d) Raspberries, blackberries, currants, and gooseberries may be grown by a system of mulching without cultivation, but it is seldom desirable to do so.

(e) While cultivation of the soil is not as successful in the conservation of moisture as mulching, when mulching is done in the best manner, it is nevertheless far better than mulching as commonly practiced.

(f) Mulching fruit plants the year round tends to encourage the development of surface roots which are liable to be injured by freezing. The roots also interfere with cultivation when the mulching is discontinued.

(g) Mulching greatly increases the risk of damage in case of fire.

(h) The mulch about plants furnishes a harbor for injurious insects, field mice, etc. These pests are most easily kept in check by clean cultivation.

COVER CROPS.

Cover crops, as used in orcharding, are the crops grown in orchards for increasing the fertility of the soil and to conserve moisture. In general, the best fruit growers are a unit in advocating the importance of clean cultivation for orchards, but this sometimes results in reducing the soil to a condition which can only be fully remedied by the addition of humus. This, however, may be supplied by the application of coarse stable litter or decayed organic matter directly to the land. In this case the humus applied is confined almost entirely to the few upper inches of the soil. By growing clover or similar deep-rooted crops the decaying roots will leave humus in the subsoil and also render it porous.

Other advantages of cover crops are (a) that they protect the soil to some extent from deep and sudden freezing and thawing; (b) they prevent the snow from blowing away in the winter; (c) such cover crops as clover and peas not only improve the physical condition of

the soils on which they grow, but also makes them richer in nitrogen. On this account they are especially valuable for orchards.

HOW TO COMBINE THE ADVANTAGES OF COVER CROPS AND CULTIVATION.

This is an important question for orchardists. In many fruit sections, this is done by the cultivation of the soil during the summer and seeding down to some cover crop in the late summer or early autumn. The crop may be one that will kill out in winter or one that will live over and be allowed to grow on the land until late spring, when it is turned under. Occasionally it is a good plan to seed an orchard down to clover for a year or two in order to increase the humus in the soil and thus prevent erosion, as for instance in the case of soils on steep hillsides where the humus has become almost exhausted. For this purpose the land should be plowed preferably in late autumn and the clover seed sown in late spring without any nurse crop.

Examples of Practical Use of Cover Crops in Various Fruit Districts.

(a) *Oats*.—Peach growers of Michigan and apple growers and nurserymen of Minnesota sow oats in their orchards about the middle of August to protect the roots of the trees against severe freezing and to prevent the leaves and snow from being blown off.

(b) *Crimson clover* is an excellent cover crop for parts of New York State and south to Alabama. It should be sown in late summer or early autumn in New York not outside of Long Island. Crimson clover is only a summer crop over the larger part of the State, but in Alabama it grows all winter.

(c) *Buckwheat* is a good cover crop for steep slopes or other places which it may be desirable to cover in summer. It should be sown in late spring.

(d) *Vetches* may sometimes be used to advantage for a cover crop and should be sown in early spring.

(e) Such perennial crops as *mammoth clover*, and even *alfalfa*, may be used as cover crops if plowed under the second year. They should be sown in orchards, without a nurse crop, in the early spring.

The following table shows the number of pounds of seed required per acre to obtain a good stand of the cover crops commonly used in this country:

Nitrogen collectors:		Nitrogen consumers:	
Alfalfa.....	pounds.. 40	Rape.....	pounds.. 9
Hairy vetch	do... 40	Turnip.....	do... 2
Cowpeas.....	do... 90	Rye.....	do... 30
Soy beans.....	do... 90	Oats.....	bushels.. 2
Velvet beans.....	do... 25	Barley.....	do... 1 $\frac{3}{4}$
Mammoth clover.....	do... 20	Buckwheat.....	do... 3 $\frac{3}{4}$
Crimson clover.....	do... 20	Corn.....	do... 1 $\frac{1}{2}$
Sweet clover.....	do... 15		

CROPS IN THE ORCHARD.

The question of cropping the orchard is an important one. As a rule, this should never be done, and yet it may often happen that while the trees are young and before they need all the space between them some other crop can be grown on the land to advantage.

The small grains are especially objectionable as cover crops because they do not permit the cultivation of the soil nor shade it sufficiently to keep it from baking. These plants also take much moisture and plant food from the soil. The same also applies to grass crops.

Potatoes and corn require the cultivation of the soil in summer, and consequently are among the best to grow in an orchard. Preference should be given to those crops that do not require the cultivation of the soil late in autumn. If the orchard is to be cropped care should be taken that the fertility of the soil is not impaired thereby, and ordinarily it will be necessary to add manure to replace the plant food removed.

Small fruits of various kinds may be used in orchards but must be removed when the trees get large enough to need all the land.

Planting with fillers is the system of planting an extra number of trees on the land with the purpose of cutting them out when they get large enough to crowd those that are to remain permanently. Good examples of this practice are found in the planting of peaches or plums in the intervals between apples or the planting of twice as many peach or plum trees as can grow to maturity, the intention being to cut out one-half as soon as the trees begin to crowd. It is not a bad practice when faithfully carried out, but, in the hands of the average cultivator, the thinning process is seldom begun soon enough, which may result in serious injury and is always harmful. (Read reference No. 14, pp. 133-174, 184-202.)

EXPERIMENT AND PRACTICE WORK, SECOND LECTURE.

I. Depth of Roots in the Soil.

Material needed.—Spade, shovel, garden trowel, and plants to work with.

Exercise.—Dig out carefully the roots of a red clover plant or those of any other of the cover crops, preserving as many of the side roots as possible. It will often be found that a small wooden paddle is better than a trowel for working around delicate roots. This work may often be done to best advantage by visiting some river bank where the water has cut away the soil and laid the roots bare, or where a bank is being excavated, that the work of following the roots may be easily done. Note the depth to which the roots penetrate the soil; also the character of the root systems of various plants.

II. Nodules on Roots.

Material needed.—Shovel, spade, trowel, collection of the roots of six different cover crops, three of nitrogen-producing and three of nitrogen-consuming plants, each preserved in a quart glass jar. A 2 per cent solution of formaldehyde is a convenient preservative.

Exercise.—Find a convenient place where some of these plants may be dug out and have the work done by the class. Call attention to the nodules on the one class of roots and the lack of nodules on the other. Examine the nodules and their contents through a microscope and note their character. This may be carried on in connection with the first exercise if thought best.

III. Impermeability of Sod.

Material needed.—A frame 6 feet square made of 2 by 4 scantling covered with woven wire. This must be strongly made and the wire be well supported in the middle. Blue-grass sod, 3 inches thick, and sufficient to cover the frame. If very dry it will shed water more freely.

Exercise.—Support the frame strongly at about one-third pitch and cover with the sod, taking pains to lap the joints so that water will not run through them. Then sprinkle water over the sod with a hose or with a rose-watering pot and note the time required to wet it through and the large amount of run-off water. This experiment furnishes an explanation of why orchards on hillsides that are in sod often suffer severely from drought.

IV. Conserving Soil Moisture.

Material needed.—Six flower pots of gallon size, half bushel of garden soil, half bushel of sharp sand, half bushel of peat, chopped straw, ground loam, and pair of scales.

Exercise.—(a) Use of mulch. Fill two flower pots with garden soil, moisten the contents, but not to the extent of causing loss from drainage; cover the top surface of one of the pots with 1 inch of dry sand, chopped straw, or ground loam, weigh, and place the pots where evaporation can take place. In twenty-four hours weigh again and note the loss of each; continue the process for six days and note the results in loss of water.

(b) Use of humus. Fill two pots, one with peat soil and another with sand, both previously dried at a mild temperature for twenty-four hours. Note the weight of each, then saturate both with water until drainage begins to appear; weigh and note the quantity of water absorbed by each; place in a warm room for twenty-four hours, then weigh, noting the differences, and repeat this process every twenty-four hours for a week and note the result.

V. Humus as a Heat Absorbent.

Material needed.—Half bushel of sharp sand, half bushel clay subsoil, half bushel garden soil, one pound of lampblack, six thermometers, and one pair of scales.

Exercise.—Fill two flower pots with sand, two with clay subsoil, and two with garden soil. Cover one of each with one-fourth inch of fine charcoal or lampblack. Expose all equally to the rays of the sun and note the difference in temperature every three hours.

THIRD LECTURE—FERTILIZER REQUIREMENTS OF FRUIT CROPS.

IMPORTANCE OF THOROUGH PREPARATION OF SOIL.

A most important factor in the growing of fruit crops is the proper preparation of the soil. This should be attended to before anything is attempted in the way of fertilization. Manure can only be used to best advantage after the soil has been put into proper physical condition. In the case of new orchards, do not plant until the soil has been thoroughly cultivated. This can be done most economically before the trees are planted.

ALL AGRICULTURAL SOILS HAVE PLANT FOOD IN THEM IN TWO FORMS.

(a) In new fruit-growing districts, where the land has not yet been cropped extensively, the soil is usually rich in plant food that is readily available for use. This is the soluble form. (b) Soils contain in addition plant food in forms not readily available to the roots of crops. Many soils consist almost wholly of this unavailable plant food. This is especially true of those that have been improperly farmed for long periods. This is the insoluble form of plant food.

Each year a portion of the insoluble plant food in the soil is rendered soluble, or at least is got into such condition that the roots of plants can use it. Where this process fails to supply an amount sufficient to produce a crop, and where there is no reserve of soluble food left from previous years upon which the plant may draw, this lack may be supplied by the addition of suitable fertilizers, either animal, vegetable, or mineral. In sections of this country longest cultivated lands of this character abound, and consequently the application of fertilizers is a necessity if a full crop is to be grown.

There are new soils already so rich in plant food that nothing is gained by manuring them. In fact, fruit trees on such soils are often injured by the use of too much fertilizer, which causes growth to continue until late in autumn. But such cases are comparatively rare. Practically all of our fruit lands, particularly those in the older fruit-growing sections, are greatly improved by the judicious application of manures.

MANURING THE ORCHARD.

In manuring the orchard one object is to get a maximum crop. The crop that is up to or possibly just below the average is seldom a profitable one. It is generally inferior in quality as well as lacking in quantity. Its defective character lowers it to such extent that it is brought in competition with the crops of all the poorest cultivators and must be sold often in a glutted market and usually to those who have small means with which to buy.

Manure will not take the place of good tillage and protection from insects and fungus diseases, but the well-fed plant, like the well-fed animal, will often overcome adverse conditions which would cause one that is weak and underfed to succumb.

The elements that enter into the composition of fruit crops are the same as those of farm crops. Although they differ somewhat in their relative proportions we need not be particular, in fertilizing an orchard, to compound the manures exactly according to these proportions. Our knowledge of soil conditions is as yet too incomplete to enable us to know the precise amount of each fertilizing ingredient to apply in order to exactly supplement the available fertility in the soil. Each grower must study his own soil conditions and test the effects of different manures on it in order to get the best results.

The chemical elements that compose our fruit and agricultural crops are oxygen, hydrogen, nitrogen, phosphorus, sulphur, iron, potassium, sodium, calcium, magnesium, chlorin, and silicon. Nitrogen, potassium, and phosphorus are the elements commonly lacking in the soil and it is these that we look for in fertilizers. These elements each act differently in affecting vegetation. To be used by plants, they must be soluble. Soil that has large amounts of soluble nitrogen in it produces a vigorous soft growth of wood and a dark green color in the leaves. On such land trees are liable to grow late in autumn and to winterkill. The fruit is likely to be low colored and of poor keeping quality. For peaches such soil is more injurious than for apples or other hardy crops.

Nitrogen encourages a growth of wood rather than fruit. Large amounts of potash and phosphoric acid in the soil cause a firm, solid growth of wood, early maturity of plant, and firm, bright colored, long keeping fruit.

Nitrogenous fertilizers in sufficient quantity can usually be supplied by the use of barnyard manure or by plowing under leguminous catch crops. Of the commercial forms nitrate of soda, sulphate of ammonia, dried blood, and tankage are most common. Potash fertilizers seldom need be applied heavily on well-tilled clay soils, as such are usually well supplied with potash. Wood ashes afford potash in a readily available form. Unleached hardwood ashes are most

useful. The leading commercial forms of potash are the sulphate and muriate and a lower grade product known as kainit. Phosphoric acid is more often lacking in the soil than potash. It is supplied by applications of ground bone, finely ground rock phosphate, either raw or after treatment with sulphuric acid, which renders the phosphoric acid much more readily available to plants. Treated ground bone or ground rock is known as acid phosphate or superphosphate.

To secure the best results each of the elements—nitrogen, phosphoric acid, and potash—must be available to the plant in the proper proportions. These elements are all necessary for healthy plant growth. The following table shows the amount of plant food, nitrogen, pot. sh, and phosphoric acid taken from the land by a crop of 75 barrels of apples. This amount is here used, as it represents a good average crop of apples per acre.

Table showing the composition of 75 barrels of apples.

Water.	Dry matter.	Nitrogen.	Phosphoric acid.	Potash.
9,563 lbs., or 85 p. ct.	1,687 lbs., or 15 p. ct.	4.5 lbs., or 0.04 p. ct.	2.25 lbs., or 0.02 p. ct.	11.25 lbs., or 0.1 p. ct.

To raise this crop of apples there must be about 50 trees, each one of which is fifteen years old. The branches, trunk, and roots of such a tree will weigh about 1,400 pounds, of which 40 per cent is water. It is probably fair to assume that the weight of the new growth of wood of a thrifty apple tree at fifteen years of age is 50 pounds per year, from which the amount of plant food used for the wood each year can be readily computed. (Reference No. 35, pp. 207-223.) It is also safe to assume that the amount of plant food yearly set free in the soil is sufficient to take care of this growth of wood. The leaves are returned to the soil and hence the manurial material in them does not have to be supplied to the soil. If therefore enough plant food is supplied to replace the manurial ingredients that were taken away from the land in the crop harvested, the land will be maintained in good condition. There is nothing very exact about the amount of manurial material removed each year as it will vary with the soil, the variety of crop, and other conditions.

The following table shows approximately the amount of plant food materials removed in one year from the soil of an acre of land fully stocked with thrifty fruit trees of the kinds named. This includes the amount contained in the new wood, foliage, and fruit.

Plant food removed from the soil of 1 acre in various fruit crops.

Kind of fruit.	Nitrogen.	Phosphoric acid.	Potash.	Lime.	Magnesium.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Apple.....	51.5	14	55	57	23
Peach.....	74.5	18	72	114	35
Pear.....	29.5	7	33	38	11
Plum.....	29.5	8.5	38	41	13

The following table shows the amount of nitrogen, phosphoric acid, and potash found in a good crop of fruit grown on 1 acre:

Plant food of manurial value removed from the land by various fruit crops.

Kind of fruit.	Fruit.	Nitrogen.	Phosphoric acid.	Potash.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Apples.....	11,250	4.5	2	11.25
Pears.....	10,000	4	1	12
Plums.....	7,200	7	3.6	14.4
Peaches.....	4,950	4	2	9
Quinces.....	7,200	8	3.6	17.2
Raspberries.....	4,800	5.6	4.3	12
Blackberries.....	4,800	9.6	2.4	11
Strawberries.....	4,000	5.2	2	9.2
Currants.....	4,000	12	4.8	12
Gooseberries.....	4,000	6	2.8	8
Grapes.....	6,000	9	4.2	18

This nutrition may be supplied in many forms. Maynard gives the following formulæ (reference No. 4, pp. 30, 31):

(a) For fruit trees over ten years of age (40 trees) varying in quantity according to the condition of the soil and crop, 250 to 500 pounds of fine-ground bone; 100 to 300 pounds of sulphate of potash; 50 to 150 pounds of nitrate of soda.

(b) Hardwood ashes at the rate of 2 tons per acre and the same amount of fine ground bone.

(c) South Carolina rock, 400 to 600 pounds, ground fine; 100 to 300 pounds of sulphate of potash; 100 to 300 pounds of nitrate of soda.

(d) Barnyard manure, 6 tons per acre.

HUMUS.

While nitrogen, potash, and phosphorus are the elements most needed in the soil, a compound known commonly as humus, although not in itself a plant food, is so useful in improving the physical condition of the soil that it should be mentioned among the fertilizers. This material is the result of the decay of vegetable matter. It is nearly analogous to charcoal in its qualities of absorbing and holding gases and moisture. In the soil humus prevents washing and keeps it open and porous, and by its own decay sets free acids and perhaps other compounds that assist in making available plant food in the soil. It is the presence of this material in stable manure that probably largely accounts for its superior action as a fertilizer in the soil.

Humus can be supplied to the soil most cheaply by means of cover crops, an important part of their value consisting in the furnishing of this material.

The value of humus is well illustrated by experiments at the Minnesota Experiment Station, where corn grown continuously for six years on the same field yielded an average of 21.4 bushels per acre, while corn in a three-year rotation, including wheat and clover, yielded 47.1 bushels per acre. As the plot producing corn continuously has sufficient plant food to mature a normal crop annually, the low yield can only be accounted for by the poor physical condition of the soil produced through the depletion of the humus by frequent cultivation. (References No. 14, pp. 202-223, or No. 28, pp. 140-147.)

EXPERIMENT AND PRACTICE WORK, THIRD LECTURE.

I. Effect of Nitrogen on Plant Growth.

Material needed.—Three pounds nitrate of soda, 5 square rods of sod land of rather poor quality, 20 stout stakes at least 2 feet long, 50 feet of measuring tape, one 10-pound scale, three 1-pound paper bags.

Exercise.—Mark out accurately 5 square rods, leaving a path 4 feet wide between each square rod. Mark each with a stake at each corner, driving it at least 1 foot into the ground. Number each plot. Weigh out three 1-pound lots of nitrate of soda and put in a paper bag. Sow evenly the contents of each of the three paper bags on one of each of the alternate square rods numbered 1, 3, 5.

NOTE.—The result of this experiment will not be apparent for perhaps two weeks, after which the grass on the plots receiving the nitrate of soda will show a much darker color than the others and will be closer in growth. The attention of the students should be called to these plots from time to time until the difference is clearly seen. This experiment is most successful early in the season, but can be carried on with success at almost any time during the growing season.

II. The Amount of Water in Fresh Fruits.

Material needed.—Six hard apples and knife to cut them. In the absence of apples, pears, quinces, or similar fruits may be used, or a quart of any of the fresh small fruits.

Exercise.—Weigh each of the six apples or other fruits that may be selected for this experiment and keep a record of the weights. Cut each fruit into thin slices and lay each in a perforated round tin dish. Dry them in an oven until apparently thoroughly dry. Weigh again and note the loss in weight which is due almost entirely to the water which has been evaporated.

III. Effect of Thorough Preparation of the Soil.

Material needed.—Half bushel of soil of average quality, six large plain glass tumblers, an ounce each of wheat and corn and half an ounce of cloverseed, two brass sieves—one with 1-millimeter mesh and the other with 3-millimeter mesh, four Argand chimneys, and a pair of scales.

Exercise.—(a) Effect of germination: Pass some soil through sieves one and two; fill three glass tumblers with a portion of the finest grade, three with the next finest, and three with the coarsest soil. Plant an equal number of grains of each of the seeds in each of the three tumblers representing the three grades of soil, covering the seeds at the usual depth. Observe the various periods of germination and stages of development of each of the kinds of seeds sown under the three conditions of soil. At the end of ten days wash the earth from the roots and observe the root development of each.

(b) Effect of fineness of soil upon its moisture-holding capacity: Secure about one-half bushel of a fine loam or clay soil and the same amount of sandy loam or sand. Take an Argand lamp chimney and cover the upper end with a muslin cloth. Turn the chimney bottom up and fill the tube part with a fine loam. Pack it by jarring on a wooden block. Fill another chimney similarly with the sandy loam. Weigh the chimneys when filled with the dry earth and record each weight. Place both chimneys in a jar of water so that the water will rise through the soils, forcing the air out ahead of it and thoroughly saturating the soil. When the water appears at the top take the chimneys out, weigh each carefully, and set them up to drain. Place a glass plate over the top of each chimney to lessen evaporation. Allow each chimney to drain for 24 hours. Weigh and record the weight. Repeat each day for at least five days. Keep a record as follows:

Sandy loam.—First, weight dry; second, weight saturated; third, weight 24 hours draining; fourth, weight 48 hours draining.

Compute the loss of water by drainage for each type at the end of 24, 48, 72, etc., hours.

Question 1. Which soil loses water more rapidly at first?

Question 2. Which ceases to drain first, and why?

Question 3. Does a coarse soil or a fine soil hold water best against drainage?

Question 4. How much water must be furnished to a crop of grass in order to produce 1 ton of hay? 40 bushels of oats? (Reference No. 64, pp. 139-141.)

IV. Comparative Profits of Crops of Fruits.

Exercise.—Compute the profit on a full crop of fruit as compared with that of the average crop, taking into account the percentages of number one, two, and culls.

FOURTH LECTURE—VARIETIES, PLANTING, AND PRUNING.

VARIETIES.

The varieties of fruit best adapted to a given location can not be named without special and careful study. Some that are very profitable in one locality in another close by, with perhaps a different soil or elevation, may be complete failures. The selection of varieties for profitable culture is one of the most important matters that the fruit grower has to consider. There are many new varieties of fruit introduced each year and few of them are any better than old standard sorts, while the greater part are almost worthless.

The several varieties of fruits in cultivation may each be divided into two general classes:

(a) Varieties of great vigor and productiveness, adapted to a wide range of country. These, as a rule, are somewhat inferior in quality but of fine appearance and good enough in quality to satisfy the average market. Among such varieties are the Duchess of Oldenburg, Talman Sweet, and Ben Davis apples; Bartlett and Anjou pears; Lombard and Quackenboss plums; Crawford and Elberta peaches; Concord and Niagara grapes; King and Cuthbert raspberries; Snyder blackberry; and Splendid and Warfield strawberries. These varieties do well over a large extent of country. They may not bring the highest prices, but sell well and are the popular standards.

(b) Another class includes varieties that are sensitive as to soil and location and are not generally successful. Where they do well their fruit is of very superior quality. As belonging to this class may be mentioned the Newtown Pippin, Gravenstein, and Williams apples; Green Gage plum; Bosc pear; Columbia peach; Iona grape; Herstine raspberry; Lawton blackberry; and Jucunda strawberry.

In selecting varieties the fruit grower should choose such as are adapted to his market, for this is where their commercial value will finally be tested. Grow what the consumer desires. You want a fruit that will sell. The grower can not expect to change very materially the prevailing tastes of people. There is, however, a constantly increasing number of people who are becoming more particular as to the quality of fruit they use and are willing to pay a fair price to secure the best. The orchardist should not undertake to grow white strawberries, white raspberries, or white currants, for the markets, as a rule, demand that these fruits be red in color and that blackberries shall be black and not white. It is not worth while to attempt to change prevailing opinions in such matters for the sake of pushing some new variety, no matter how good its quality. Consumers generally want large size, bright warm colors, and at least fair quality in fruits.

The fruit grower should not select varieties because they are doing well elsewhere, but should become familiar with the experience of successful fruit growers in his section, and also get in touch with the experiment station men of his State and advise with them in these matters. He should study carefully the reports of his State and local horticultural societies, both of which ought to be very helpful.

Varieties should be selected that will pollenize well together. There are some varieties of fruits that are self-sterile and which will not be productive unless near other similar kinds that will furnish suitable pollen. (Reference No. 16, pp. 224-230.)

The following partial lists show varieties that are both self-sterile and self-fertile:

List of self-sterile and self-fertile varieties of fruits.

Fruit.	Self-sterile.	Self-fertile.
Plums.....	Miner.....	Robinson.
	Wild Goose.....	De Sota.
	Mariana.....	Rollingstone.
	Itaska.....	Forest Garden.
		Cheney.
Grapes.....		New Ulm.
	Brighton.....	Concord.
	Wilder.....	Niagara.
		Agawam.
		Delaware.
Apples.....	Winesap.....	Ben Davis.
	Gravenstein.....	Duchess of Oldenburg.
	Northern Spy.....	Baldwin.
Pears.....		Red Astrakan.
	Bartlett.....	Flemish Beauty.
	Anjou.....	Clairgeau.
	Nelis.....	Kieffer.

PREPARING THE LAND.

(a) The land on which the fruit plantation is to stand should be put in as good condition as possible before the plants are set out. Do not leave this work to be done after the trees are planted. It not only costs more to do it then, but the trees will very likely be injured in the process.

(b) Get the land into condition fit to grow a first-class crop of corn.

TIME TO PLANT.

(a) In very cold latitudes and with the more tender kinds of fruit, the early spring is undoubtedly the best time for planting. It is also preferable for a beginner even with hardy plants. The soil is then moist and loose, all kinds of vegetation are starting, and trees set out at this season take root at once and begin to grow under the most favorable conditions of soil and climate.

(b) For hardy fruits, such as apples, plums, and pears, in sections where there is little danger of winter injury, autumn is a good time, if not the best season for planting.

(c) It is often desirable to plant in autumn, in order to save the crowding of work in the spring. In severe locations autumn planting may be practiced successfully, provided the stems of plants are laid flat on the ground after planting and covered with a few inches of earth. In doing this the location of the top of the tree should be marked with a stake, so that it may be found easily in the spring when it is to be uncovered.

SELECTING THE TREE NURSERY STOCK.

(a) Select vigorous, thrifty stock, free from scale insects, root lice, or other injurious insects or diseases.

(b) Select trees that have bark as "green as grass" and that have made a thrifty growth the year before.

(c) In the case of grafted fruits, the grower should insist upon having his stock worked on roots adapted to his location. This feature does not need so much attention in the best fruit sections, but in cold northern climates, in the extreme South, and in California it is a matter of first importance. This feature is discussed in the lecture on the propagation of each fruit.

Age of nursery stock to buy.—(a) As a rule young nursery stock is to be preferred. The tendency is to buy that which is too old.

(b) Old plants are much more injured by moving than those that are young and seldom give as satisfactory results.

(c) In order to get at the autumn delivery early, it is customary in some nurseries to strip the leaves from the trees. This is a bad practice and such trees should be avoided.

WHERE TO BUY.

(a) Buy from the nearest nursery that will furnish good trees at fair prices. Buying near at hand saves freight.

(b) Buy of honest nurserymen and buy from them direct rather than through their agents.

(c) Expect to pay a fair price and be suspicious of "bargain counter" nursery stock. The buyer in all such cases is largely dependent upon the honesty of the seller as to the genuineness of his stock. You can not always determine its character by its appearance. (Reference No. 14, pp. 230-237.)

SHAPES OF TREES.

(a) The general public prefer a tree that is of good form and the nurserymen usually grow that kind.

(b) Some of the best varieties are so crooked that they do not look well, and since this affects the demand and price they have not been pushed by nurserymen.

(c) The difference in the form of trees can be easily distinguished in any orchard in which there are many varieties. The upright form of the Tetofsky apple is in marked contrast with the spreading branches of the Roxbury Russett. The spreading head of the Wild Goose plum is altogether different from that of the Lombard. Any one familiar with the appearance of certain varieties of fruit trees, as pears or apples, can easily identify them by their appearance even when devoid of foliage.

HOW SHALL WE PLANT AN ORCHARD?

There are several ways of laying out an orchard. The two methods most commonly followed are setting in squares and setting alternately. It is important to have the rows straight both ways. The orchard will look better and the trees are more convenient for cultivation. Straight rows may be made in various ways, but perhaps there is no better way than by setting the trees around the outside first, or if the orchard is very large, by planting a row every 40 rods. By using these outside or middle-row trees as sight stakes, the lines of trees may easily be made straight both ways. If the land is laid off carefully, using a corn marker one way and a plow the other, the intersections will indicate the proper place for planting, and the exact point be fixed by sighting to the trees at the ends of the rows. (References No. 14, pp. 254-276; No. 26, pp. 61-63, or No. 4, pp. 17-24.)

Digging the holes.—(a) In digging the holes, make them large enough to receive the roots without crowding and deep enough to bring the union of the stock and scion well below the surface. Trees should generally be planted a little deeper than they grew in the nursery. In severe climates they are sometimes planted as much as a foot deeper to protect from injury by frost.

(b) In the case of fruit trees, if the land has been properly plowed and furrowed out, but little digging will be required.

(c) In digging holes in shallow soil, keep the surface and subsoils separate, then use the surface soil for covering the roots and place the subsoil on top. (References No. 14, pp. 244-254; No. 11, pp. 109-113, or No. 26, pp. 63-73.)

PRUNING.

(a) Trees may be left until after they are set out before pruning except that they may sometimes with advantage be pruned at the nursery to save freight.

(b) Severe pruning is often needed for young trees, since much depends upon the proper forming of the head of the tree at this time.

(c) No pruning point is more important than that of deciding at what height the trees shall branch out. This will depend very much on location.

(d) In New England, where the climate is comparatively cool, trees with long trunks are in favor as tending to facilitate cultivation. In the Middle and Pacific coast States the best results have come from allowing the branches to start within 2 feet or even closer to the ground and thus the trunk is protected against sunscald.

In orchard practice trees are pruned—

(a) To remove all dead or decaying branches or branches which rub against each other.

(b) To shorten the annual growth for the purpose of making the tree more compact, better able to carry a load of fruit without breaking, more easy to cultivate, spray, and harvest the fruit.

(c) As a means of thinning fruit to secure increased size and quality.

(d) To rejuvenate old or weak trees.

(e) To control certain diseases, like pear blight.

(f) To make the trees more shapely or to train them into some special form.

Trees are sometimes root-pruned to check a too rank, vigorous wood growth, and thus throw them into bearing. Ringing a branch or trunk has a like effect. It is most frequently practiced with grapes to secure a larger earlier fruit.

Some of the more essential points to be remembered in pruning are:

(a) To cut all large branches close to the trunk from which they spring and parallel with it. Where only the annual growth is removed the cut should be immediately above a bud.

(b) To prevent decay the cut should be made smooth and painted with some such material as lead paint, grafting wax, etc.

(c) To prevent splitting of the trunk the branches should be trained out at different heights around the trunk and acute crotches avoided.

(d) Severe top pruning has a stimulating effect, resulting in a vigorous growth of new shoots and is most useful in rejuvenating an old orchard.

(e) Severely winter-injured trees should be only mildly pruned. If the fruit buds only are killed the pruning may be more severe.

(f) Wounds heal over best if the pruning is done during the growing season, but for convenience sake and also to prevent bleeding in the case of grapes, it is generally done in early spring before the growth starts in the tree.

Pinching or disbudding is a modified form of pruning and relates to the removal of buds. By removing the terminal bud of a branch the development of lateral buds and shoots is encouraged. Pinching is most commonly practiced with raspberries.

(References No. 55, pp. 73, and No. 16, pp. 135-142, 157-163, 180-190.)

EXPERIMENT AND PRACTICE WORK, FOURTH LECTURE.

I. Grades in Nursery Stock.

Material needed.—Good specimens of nursery stock of each of the various sizes and ages usually sold for planting should be provided for each student. This will include specimens of one, two, and three year old apple, pear, plum, and cherry trees; one-year-old peach trees, and specimens of the various small fruit plants.

NOTE.—If this exercise is given during the growing season, when the stock can not be obtained in dormant condition, it will be a good plan to substitute for it a visit to some good nursery or near-by fruit grower, where the trees may be seen growing and where attention can be directed to the different grades and their peculiarities. A rough drawing should be made indicating the special feature of each class.

Exercise.—Bring the specimens of nursery stock mentioned before the class, give the age of all the different sizes exhibited, and point out their good and bad features for orchard purposes. A number of them should be pruned by the class into proper shape for planting out. Exhibit also some specimens of poor or worthless stock, such as are sometimes sent out by nurserymen.

Special attention should be called to the habits of different kinds of trees as developed in orchards. For instance, some trees as the Roxbury Russett, are spreading in their habits, while others, like the Tetofsky and Whitney, are erect. Require the students to study these characteristics and enter descriptions of them in note books illustrated by drawings.

II. Heeling in Nursery Stock.

Material needed.—At least twenty fruit trees, and twenty each of currant, gooseberry, raspberry, and strawberry plants, all of transplanting size; a spade and 1 square rod of loose loamy ground.

Exercise.—(a) Heel in the nursery stock in a standing position in a shallow trench, as is customary where stock is temporarily stored. Great pains should be taken in this exercise to impress upon the students the importance of packing the soil thoroughly among and around the roots so as to insure that each root is firmly embedded in fine soil. (b) Heel in for storage over winter, as is customary in late autumn, putting the trees in a trench at least 2 feet deep and then bending down the tops and covering with soil. Put in the small fruit plants and cover them also with soil.

III. Setting out Plants.

Material needed.—Twelve fruit trees of good transplanting size, twelve currant bushes, twelve strawberry plants, a 50-foot line, and a piece of well-worked loam soil 50 by 50 feet square.

Exercise.—Dig holes and set out the twelve trees in straight rows. Make the holes just large enough to receive the roots without crowding. In digging the holes, take care to put the top soil around the roots so that the subsoil will come on top. Before setting out the trees, prune the roots. They should be set about 3 inches deeper than they grew in the nursery.

Set the currant bushes in the same way. The strawberry plants should be set with a spade, taking care to place them at the same depth that they grew in the nursery. Care should be taken to call the attention of the students to the common error of setting strawberry plants either too deep or too shallow.

NOTE.—If this exercise is given to take the place of the first exercise, it will be a good plan to prune the trees after they are set out.

IV. Orchard Plans.

Material needed.—Brown drawing paper and pencils.

Exercise.—Make a plat on paper of an orchard of 5 acres of large and small fruits, naming the kinds of fruits and varieties of each kind best adapted to the local market and for home use.

FIFTH LECTURE—ORCHARD PROTECTION.

Throughout the whole life of fruit plants there is danger of injury from a variety of causes. Among the more common of these may be mentioned sunscald; winterkilling of the twigs and roots; winterkilling of the fruit buds; sleet storms; injuries from birds and live stock, from wind, rain, and frost in the growing season; girdling by mice and rabbits; and injury from label wires, insects, and diseases.

SUNSCALD.

This is the name given to a condition of the bark of trees which is probably the result of exposure to the sun under peculiar conditions. Its effect is usually to injure the bark on the south and southwest sides of the tree which later peels off leaving the wood exposed. This soon begins to decay and permanent injury results. It has been found that shading the trunk will prevent this injury, hence a common remedy is to cover the trunk with burlap, cornstalks, or similar material, especially during the time when not protected by leaves. The growing of branches on the south side of the tree so as to shade the trunk from the sun and the inclining of the trees toward the southwest are also effective remedies.

This injury is most liable to occur during severe droughts and in the early spring or late winter before growth has fairly begun. It is supposed to be caused by the warm sun of the middle of the day starting active life in the portion of the trunk exposed to its direct rays. Later, when a cold spell comes, the soluble compounds formed by the renewal of active life are decomposed and the protoplasm is destroyed. The trees most liable to this injury are those that are newly set and weak; such as have smooth bark, as hard maple and basswood; also trees with trunks inclining to the northeast and those on dry land.

It is well known that one portion of a dormant plant may start into growth independently of the condition of the rest of the plant. Thus a branch from a grapevine or other plant brought through an opening into a greenhouse in winter will soon start into growth while the rest of the vine out of doors is frozen. In like manner the portion of the trunk of an apple tree that is exposed to the direct rays of midday sun may start into growth independently of the rest of the tree.

WINTERKILLING.

This may be confined to the twigs and flower buds of fruit trees. Injury from this cause is most liable to occur in valleys. On the adjacent higher land there may be comparative immunity.

WHERE FROSTS ARE MOST LIKELY TO DO INJURY.

Frosts are most likely to do injury in places where the air is stagnant, especially in low spots where the air is not affected by light winds and into which the cold air from the surrounding elevations drains. Such places are indicated when the first severe autumn frosts occur, particularly if the night be calm. The dense cold air flowing into the lowlands fills the hollows and cools vegetation to the temperature of frost. In such places winterkilling is frequently serious. A windbreak may also make a frost pocket even on a side hill by interfering with the free circulation of air.

In districts where injurious frosts occur, high elevations tipping to the north or east where vegetation is rather backward in the spring afford the best locations for fruit growing. Other locations comparatively exempt from injurious frosts are such as are near lakes or large streams, which tend to produce an equable climate.

WINTER INJURY TO TWIGS AND TRUNKS.

This is commonly due to the use of varieties too tender for the locality. The most successful remedy is to secure hardier sorts. When this is not possible, or the varieties grown may be particularly profitable, the trunk is protected in winter. In northern Minnesota the best authorities recommend that the trunks of young apple trees be surrounded with a box 6 inches square reaching to the branches and filled

with soil to furnish protection against winter injury. They have discovered that even if the smaller branches are seriously injured by the winter, they stand a good chance of recovering, provided the trunk is uninjured. This protection also prevents sunscald, injuries from mice and from cultivation. In Florida some orange growers protect their tree trunks by piling the soil about them as far up as the branches. (Reference No. 14, pp. 313-321.)

INJURY TO THE BUDS OF FRUIT TREES.

This is a common source of loss to growers of cherries and peaches at the North. The fruit buds of these trees are liable to start slightly in warm winter days, and to be killed by the following low temperature, although the leaf buds may not be injured. Various remedies have been prescribed for this, among the most successful where the trees are small, bending them over in autumn and covering with cornstalks. The tops sometimes are tied together and covered with cornstalks or matting. Experiments have also been made in covering the trees with various paint compounds for the purpose of giving an extra covering to the buds, but without good results. One of the most ingenious ways of furnishing protection to peach buds has been tried by Professor Whitten, of the Missouri Experiment Station, who applied the principle that dark colors absorb more heat than light ones. He discovered that light-colored peach twigs were slower starting into growth than those that are dark, and conceived the idea of spraying peach trees with lime wash. He claims to have been very successful in this practice.

INJURY BY BIRDS.

Certain birds are often very destructive to cherries, raspberries, and similar fruits. As a rule the birds that commit these depredations are very helpful in destroying large numbers of injurious insects, and the toll they take in fruit is not more than they are justly entitled to. The "sap sucker" (*Sphyrapicus varius*), on the other hand, often girdles the trunks and larger branches of our choicest trees, and in this way does much injury. Yet the woodpeckers as a class are exceedingly beneficial, and even the "sap sucker" destroys great numbers of insects.

Ruffed grouse sometimes eat the buds of fruit trees in winter, but they rarely or never cause loss to the farmer, since the quality of the fruit is improved by the process.

INJURY TO ROOTS.

This may result from the use of a root stock too tender for the section in which the tree is grown. In Iowa, North Dakota, South Dakota, and Minnesota the best root to use for the plum is the *Prunus*

americana, but when these are scarce the nurserymen use the Mariana, Myrobalan, and even the peach for stocks. The plum takes well on these last-named stocks, and they are commonly used in mild climates, but with such roots trees are often injured or killed out entirely by the severe winters of the extreme north. It is important, therefore, to have fruit trees on hardy roots in order to prevent winterkilling. Heavy mulching about trees that are on tender roots will often secure them against winter injury. Deep planting brings the roots where they are not injured, and the scion above, if of hardy stock, will generally send out roots correspondingly hardy. If, however, the scion has rooted, and the lower tender stock is injured by freezing, the effect is a weakened growth until a new root system has formed.

INJURY BY STOCK.

In remote sections deer browse the twigs of fruit trees and break them down. Farm stock is frequently injurious in the same way. Reasonable precautions will prevent this. Cattle are usually more injurious than hogs in the orchard.

INJURY BY WIND.

Wind often causes much damage to trees heavily laden with fruit by shaking it off and breaking the branches. The remedies are the use of wind-breaks and the supporting of branches by stakes or by tying one limb to another on the opposite side of the tree. Young trees in exposed situations are often injured by being blown about. This is particularly true in the case of trees that are newly set, especially those that have been set out in autumn. During the spring when the ground is soft the tree is easily loosened and killed. Autumn-set trees should always be staked if they are large enough to catch the wind. A pile of soil about a foot high around them will often protect them. In staking, the method of tying the tree so that it will not be scraped by the stake is very important. It would be better not to use stakes at all than not to secure the tree properly to them. (Reference No. 14, pp. 62-92.)

INJURY BY MICE AND RABBITS.

Mice and rabbits frequently eat the bark off fruit trees. Where this injury only extends around a portion of the tree it will often heal over quite readily. Healing can be greatly hastened by covering the wound with grafting wax, or, better yet, by piling up the soil over it if near the ground. When the injury extends completely around the trunk and is wide the tree may be saved by setting some scions in the live bark above and below the wound which will carry over the sap until the wound is healed. In such case, however, the wound should be entirely covered with grafting wax or clay after the scions are put in.

CULTIVATION INJURIES.

Cultivation is frequently done in such a rough way as to cause serious injury. This can be largely prevented by the use of narrow singletrees and by protecting the ends with leather, or, better still, by using leather traces that go completely around the end of the singletree. The best way of treating wounds of this kind is by applying grafting wax or grafting clay and then covering the whole with burlap to keep it in place.

ROOT GALLS.

Root galls are often exceedingly injurious. Some of them, however, do but little harm. Prevention is better than cure, and it is safest to refuse to receive nursery stock having such blemishes.

EXPERIMENT AND PRACTICE WORK, FIFTH LECTURE.

I. Protection from Sunscald.

Material needed.—One tree trunk about 3 feet to the branches, not over 3 inches in diameter; specimens of trees injured by sunscald; one lath screen prepared to fit the tree; one piece of rosin-sized builders' paper; ball of binder twine; one piece of burlap 12 by 36 inches; one bundle of cornstalks.

Exercise.—Have the students surround the tree trunk successively with lath screen, wooden box, rosin-sized paper, burlap, and cornstalks, using the binder twine to tie when needed. In the case of the wooden box and lath screen protect the crotches of the tree with a small bunch of hay after putting them on. In this exercise call attention to the protection given the trunk when the tree slopes to the southwest, and to the fact that when the trunk slopes to the northeast it gets the direct rays of the sun, and hence is more liable to injury.

II. Protection from Mice and Rabbits.

Material needed.—Wooden box used in the first exercise; 1 apple-tree trunk set in the ground; 1 spade; 1 grafting knife; half a dozen apple scions; 1 pound of grafting wax; 1 bucket whitewash; one-half ounce of carbolic acid; 1 ounce of Paris green; 1 small hand force pump; 1 Bordeaux nozzle.

Exercise.—Use a tree trunk in the field, preferably an orchard tree in place. Bank up the tree with soil to the height of 12 inches, making the bank as steep as it will stand, and using not over 6 spadefuls of earth for this purpose. This is to protect it from mice.

Fix the wooden box about the tree and bank with a little soil to make it tight at the bottom. This also protects from mice and partly from rabbits.

Spray the dormant tree above the box with whitewash to which has been added a small amount of carbolic acid and some Paris green. This protects from rabbits. Imitate the work of mice by scraping away the bark, and then bridge the injury with scions and cover with grafting wax.

III. Winterkilling of Fruit Buds.

Material needed.—Branches of peach or cherry trees, paper, and pencils.

Exercise.—If this lecture is given in winter the branches of peach or cherry trees should be brought into the class room from time to time for examination to determine whether they are injured or not. The buds should be studied and analyzed until each student knows a fruit from a leaf bud. The buds of the lilac and other plants that have large winter fruit buds should be used to familiarize the students with the general subject of leaf buds. Drawings should be made of the fruit and leaf buds of several kinds of plants.

IV. Cultivation Injuries.

Material needed.—Two or three singletrees ordinarily used by farmers in cultivation; a singletree not over 15 inches long, with its ends properly protected with burlap or leather traces; several specimens of trees that have been injured by singletrees.

Exercise.—Call attention to the length of the singletrees used and that the short one used is long enough. Have students measure and also put protection on each to prevent the injuries.

V. Laying Down and Covering Plants.

Material needed.—One good raspberry plant, set out in good garden soil, or a row of raspberries or blackberries ready to be laid down; one good peach or plum tree; two spades; four or five shocks of cornstalks.

Exercise.—Bend the raspberry over and cover with several inches of soil or enough to hold it in place. The plant must bend in its roots to get the best results. It will not do to depend entirely upon bending the canes. Lay the peach tree down in a similar way, taking care to bend it in its roots, which are exceedingly tough and pliable. When bent down, tie the branches to stakes driven in the ground and cover with cornstalks. The earth must be removed from the roots of the peach trees before it will bend over, and attention should be called to the flexibility of the younger portion of the peach-tree roots.

NOTE.—The season of the year at which this lecture is given will influence very much the practice exercises. If given when there are severe late frosts many exercises will be possible showing the difference between frost tender and frost hardy plants; also the effect of frost on flowers, and assist in discovering locations most susceptible to frosts.

VI. Map of Frost-liable Locations.

Material needed.—Paper and pencils.

Exercise.—Let each student map some district with which he is familiar, showing the elevations by general contour lines, and note the locations in which frost is especially troublesome. For students that have no definite district in mind assign a near-by area and let them indicate where they think late and early frosts are most likely to occur.

SIXTH LECTURE—THE CONTROL OF INJURIOUS INSECTS AND DISEASES.^a

EXTENT OF INJURY BY INSECTS AND DISEASES.

The work of the fruit grower is not confined to tillage, pruning, and fertilizing, but extends also to the protection of his orchard against insect enemies and plant diseases. The fact that large areas have been devoted to fruits of special kinds, as apple, pear, peach, grape, etc., has favored the multiplication of the insect enemies and fungus diseases of the respective crops, and at the present time their control is one of the important requisites in successful fruit growing. A large proportion of the insects and diseases attacking fruit crops may be more or less injurious every year in the area of their distribution, and some few excessively so. Most insects have periods of abundance, and then become less destructive for a while, owing to the influence of natural agents, as climate, parasitic and predaceous insects, fungus diseases, etc. Certain insects and diseases, as the codling moth, San José scale, peach borer and plum curculio, the apple scab, apple bitter rot, pear blight, black rot of grape, etc., all serious troubles, are quite destructive almost every year and inflict an enormous loss, amounting to many millions of dollars.

On the clearing and planting to fruit crops of large areas of land native insects which normally feed on nearly related wild plants attack the cultivated varieties, and by reason of the large amount of palatable fruit become enormously abundant and destructive. Many of our worst insect pests are native to other countries, and have been brought to this country on imported fruits or plants, as the codling moth, San José and other scales, pear-tree psylla, gipsy moth, etc. On the other hand, numerous insects native to America have found their way to other countries, some of them becoming much more destructive than at home, as the grape phylloxera, which has caused losses of many millions of dollars to the grape growers of France.

^a The part of this lecture relating to insects was prepared by A. L. Quaintance, of the Bureau of Entomology of this Department.

In the present treatment attention is confined to insects in relation to the fruit grower, and are to be considered as (a) injurious, and (b) beneficial.

INJURIOUS INSECTS.

Insects obtain their food in essentially two ways, (1) by actually eating with their mandibles portions of the plant, as leaves, buds, and fruit, and (2) by sucking out the juices of the interior of the plant by means of sucking mouth parts. The former class are designated biting insects, illustrated by grasshoppers, caterpillars, beetles, and their grubs, etc., and the latter as sucking insects, as plant lice, scale insects, and the true bugs. Biting insects when feeding on exposed portions of plants are readily destroyed by poison sprayed or dusted on the parts attacked. Sucking insects can not be destroyed in this way, and insecticides are used that kill the insects by their caustic action on their bodies or which close their breathing pores. Both of the above classes of insects may be destroyed by poisoning with gases the air which they breathe. Bearing in mind the above distinctions as to feeding habits, insects are best considered with respect to the parts of the plant attacked.

Root-feeding insects.—Numerous species of insects infest the underground portions of plants. Among the sucking insects are the woolly apple aphid, which sucks the juices from the roots of the apple, causing knots or enlargements; the grape phylloxera, which similarly infests the roots of the grape, and the black peach aphid, infesting the roots of the peach. All of these have aerial forms which serve to distribute the species. Among biting insects are grapevine root worms, the larvæ or grubs of a small brownish beetle, which feed upon the smaller roots and rootlets, and scars the larger roots of the grapevines, causing their decline or death; and larvæ or grubs of May beetles, which attack the roots of various plants, especially strawberries. Root feeding insects are difficult at best to control. The woolly apple aphid and the peach aphid may be destroyed by liberal applications of tobacco dust applied around the base of the plants. The grape phylloxera does not seriously injure the roots of certain American species of grapes and their varieties, as *Vitis vulpina*, *Vitis rupestris*, and *Vitis berlandieri*, and roots of these are now generally used as grafting stock. This pest is also controlled by injections into the ground of carbon bisulphid, a liquid yielding a poisonous gas. Insects such as the grape root worm and white grubs are greatly reduced by timely cultivations of the infested soil, and the adults of the former may be killed by poisoning the foliage upon which they feed.

Boring insects.—Larvæ of several different kinds of insects bore into the trunk, limbs, and roots of fruit trees and plants, eating the soft tissue beneath the bark or penetrating deeper, and these also are quite

difficult to control. Two species of borers seriously attack the lower trunk of apple trees, namely, the flat-headed apple-tree borer and the round-headed apple-tree borer, and one or two borers infest the peach at the crown or on the trunk. The fruit-tree bark-beetle or shot-hole borer attacks the limbs and trunk of sickly trees, peppering them with holes, soon causing their death, and in the absence of suitable food also attacks apparently healthy trees. The stems of currants and gooseberries are attacked by several borers, as are also the stems and roots of raspberry and blackberry. Injury from borers affecting fruit trees is more or less prevented by the use of washes painted on the crown or lower trunk, by wrapping the trunk with newspaper or similar paper, or mounding the earth around the base of the tree, or the two latter methods are often used in conjunction. A good method is to carefully examine the trees in the spring and fall, and to cut out and destroy the larvæ. Borers infesting currants and gooseberries, and especially raspberries and blackberries, are best controlled by cutting out and destroying infested canes during the operation of pruning.

Leaf and bud feeding insects.—The buds and foliage of all horticultural crops are attacked by a host of sucking and biting insects. Among the former are plant lice, scale insects and true bugs, as the tarnished plant bug, etc. The leaf feeders are grasshoppers, caterpillars, beetles, and their grubs, slugs, etc. Larvæ of the apple-bud moth, the grapevine flea beetle, and others scoop out the buds in early spring, and when abundant quite prevent the appearance of foliage and fruit. The apple-tree tent caterpillar, the rose chafer, fall webworm, cankerworms, the pear slug, larvæ of the gipsy moth and brown-tail moth devour or skeletonize the foliage, often leaving the trees as bare as in midwinter. Insects feeding on buds and leaves are ordinarily controlled with arsenical sprays, and plant lice and other sucking insects must be treated with caustic washes, as whale-oil soap, kerosene emulsion, etc.

Scale insects.—Scale insects constitute a rather distinct class of pests, infesting mostly the younger branches of fruit trees, sucking out the sap for food by means of slender setæ pushed through the bark into the live plant cells. Most of the scale insects which infest fruit trees are incapable of locomotion except for a short time after birth, and the adult males soon settle down, losing their appendages, and secrete a scale-like, waxy covering, which renders them more difficult to destroy. An important scale pest is the San José scale, native to China, which was found to be established in California orchards in the early seventies. This species was introduced into the eastern United States in about 1887, and has now become generally established in the deciduous fruit orchards east of the Mississippi River, and is gradually spreading through the orchards of the middle West. It has destroyed many thousands of trees, but is now

satisfactorily controlled by the lime-sulphur wash. Other scale insects are the oyster-shell bark-louse, the scurfy scale, European fruit scale, peach lecanium, etc. Scale insects are distributed principally on nursery stock, and once established in a locality, under conditions of neglect spread more or less rapidly from tree to tree, and to other orchards. They are best controlled by spraying infested trees during the dormant season with strong washes, such as the lime-sulphur wash, whale-oil soap, and kerosene and petroleum emulsions. Nursery stock is now generally fumigated with hydrocyanic-acid gas before being shipped from a nursery or before being planted, and this practice, when properly done, is a great safeguard against the dissemination of noxious scales and other insects.

Fruit-eating insects.—The codling moth is best known among these, the larvæ feeding within the apple, pear, and other fruits, and is the cause of the so-called wormy apple. In unsprayed orchards this pest destroys every year from one-third to one-half of the apple crop, and often much more. The apple maggot, the young of a small fly, burrows and tunnels the apple, especially attacking late summer or early fall varieties. Wormy peaches, plums, and cherries in the East result mostly from the work of the larvæ or grub of the plum curculio, a small snout beetle, which latter causes knotty apples and pears. A related species, the quince curculio, similarly injures the quince. Wormy grapes are produced by the grub of another snout beetle, the grape curculio, and also by the larva of the grape-berry moth. Two or three different species of insects produce wormy currants and gooseberries. With most fruit-eating insects the peculiarities in their life habits permit of their control to an important extent. Thus the larva of the codling moth mostly seeks entrance to the fruit at the blossom end and feeds within the calyx cavity of the apple for a few days before boring into the interior. The practice is to spray the trees as soon as the blossoms have fallen and while the calyx lobes are open to fill the cups with poison, which will serve to destroy the larvæ as they later seek to enter the fruit. The grape and plum curculio are also greatly reduced by spraying the plants early in the season, as the overwintering beetles feed enough on the foliage and buds to insure their destruction. Larvæ of the first brood of the grape-berry moths feed on the grape cluster before blooming or shortly after, and are likewise similarly controlled. The apple maggot may not be poisoned, and pasturing orchards with sheep or hogs to destroy the fallen apples, or gathering them by hand, is about all that may be done.

INSECTICIDES AND SPRAYING MACHINERY.

Insecticides.—Many natural agencies destroy insects, as rains, sudden changes of temperature, winds, predaceous and parasitic insects,

fungus and bacterial diseases, etc. These agencies are of the utmost importance in preventing their undue increase, but with some species they are quite inadequate, and artificial means must be adopted by man to secure their subjugation. The fight against insects may be waged in various ways, as the use of resistant stock, timely cultivation, use of fertilizers to stimulate plant growth, clean culture, etc., but these latter are mostly adjuncts to the use of insecticides—materials which are used to destroy insects. Insecticides are of three general classes: (1) Poisons for biting insects, as Paris green, arsenate of lead, Scheele's green, arsenite of lime, hellebore, etc., to be eaten with their food; (2) caustic or suffocating washes for sucking insects which corrode the body integument or stop the breathing pores, as resin wash, sulphur spray, whale-oil soap, kerosene emulsion, lime-sulphur wash, etc.; (3) poisonous gases, effective against both biting and sucking insects which poison the air breathed by the insects, as carbon bisulphid, hydrocyanic-acid gas, and sulphur dioxide.

Paris green is used at the rate of 1 pound to from 100 to 200 gallons of water, depending on the plants to be treated. Apple and grape foliage are less easily injured than peach, plum, and cherry, and only very weak solutions may be used on these latter. Arsenate of lead is coming into general use, and may be employed at the rate of from 2 to 6 pounds to 50 gallons of water without injury to foliage of most plants. Arsenical poisons are mostly used on fruit trees in Bordeaux mixture for fungus diseases. When used in water, the milk of lime made from slaking 2 to 3 pounds of good stone lime to each 50 gallons of water should always be added to destroy possible caustic effect of the arsenicals.

Of contact insecticides some are used very strong on dormant trees, especially against scale insects, and the same preparations, more diluted, may be used for the control of plant lice and other insects when the trees are in foliage. An excellent dormant tree treatment for scale insects is the lime-sulphur wash, made by boiling together for an hour 20 pounds of lime, 15 pounds of sulphur, in 15 or 20 gallons of water, and finally diluted to make 50 gallons of wash. Other dormant tree treatments are whale-oil soap, used at the rate of 2 pounds to the gallon of water, which must be applied while warm, and 20 to 25 per cent kerosene or crude petroleum emulsion. When applied to trees in foliage whale-oil soap is used at the rate of 1 pound to 5 or 6 gallons of water and the kerosene emulsion should not contain more than 15 per cent kerosene.

Hydrocyanic-acid gas is the standard fumigant for nursery stock. It is used at the rate of 1 ounce to 100 cubic feet of space. It was formerly used in a limited way in fumigating deciduous fruit trees, but this practice has now largely been abandoned. It is, however, largely used in fumigating citrus trees in California. Carbon bisul-

phid is the standard treatment for the destruction of insects when occurring in stored grain, and is also used to destroy root-infesting plant lice and other insects.

Spraying machinery.—Insect control in orchards mostly takes the form of spraying. Many kinds of spray pumps are now on the market, ranging from bucket and knapsack pumps to barrel and tank outfits or gasoline or other forms of power sprayers. The fruit grower is thus able to select a machine suitable to his own needs. The nozzle is perhaps the most important feature of a spraying outfit, and care should be taken that the right sort be secured. The Vermorel type is best. In applying the spray the work must be done very thoroughly, and the fruit grower should have an accurate knowledge of the insects which he is trying to combat. A satisfactory spray should be very fine and mistlike, so that the foliage and fruit will be uniformly peppered with fine dots of the spray mixture.

BENEFICIAL INSECTS.

Insects are beneficial to man in numerous ways, as furnishing food and clothing (as honey and silk), materials used in the arts and sciences, as cochineal dye, shellac, Chinese white, and in some countries they are an article of food. By far the greatest benefit comes, however, from their warfare among themselves, whereby noxious species are kept reduced. For present purposes insects may be considered as parasitic and predaceous.

Parasitic insects.—These are mostly small to minute wasps, but also some two-winged flies, which deposit their eggs in or on the eggs, larvæ, or pupæ of their hosts, on which the resulting larvæ feed. The hymenopterous families of Ichneumonidæ, Braconidæ, Chalcididæ, and Proctotrypidæ are largely composed of insects which parasitize other species, rendering enormous service to the fruit grower. Species of *Microgaster* attack sphinx and other larvæ in vineyards and elsewhere, and one often sees a feeble caterpillar with its back covered with the brilliant white bodies of the cocoons of these parasites. Plant lice are parasitized by species of *Aphidius*, the adult cutting a round hole in the back of its host on leaving, and the chalcis flies attack the smaller insects or even eggs, and include a long list of highly beneficial forms. The chalcis fly, *Trichogramma pretiosa* Riley, destroys the eggs of the codling moth, the cotton bollworm, and cotton-leaf caterpillar. Proctotrypids are among the smaller insects, and parasitize principally the eggs of other species.

In the Diptera the bee flies (*Bombylidæ*) parasitize the larvæ and pupæ of moths and wasps, and also the egg sacs of grasshoppers. Larvæ or maggots of Tachnid flies are parasites principally of caterpillars, and are important checks to the increase of injurious insects.

Predaceous insects.—These are predatory insects, searching out their prey, which they attack and destroy. Predaceous insects include those with sucking and biting mouth parts. Among the former are the assassin bugs, as the blood-sucking cone-nose and the wheel bug; also the spined soldier bug and the little Triphleps. These all impale their victim on their beak, sucking out the body juices. Among the latter are the praying mantis, tiger beetles, ladybirds, and wasps, some of which latter paralyze their prey, to be stored in their nests for future use of their young. The ladybirds (*Coccinellidæ*) constitute a large family of small hemispherical beetles, more or less marked with red, yellow, or black, which feed on plant lice and scale insects. Numerous attempts have been made to establish these in orchards, to secure the subjugation of destructive species, as the importation of the Vedalia, which now controls the cottony cushion scale in California, and the Chinese ladybird, brought over from China to destroy the San José scale. While it is a pleasing proposition to secure the control of insects by arraying them against each other, in general, the fruit grower must depend on the intelligent use of sprays.

INSECT CONTROL BY LEGISLATION.

Most of the States now have laws regarding the inspection of nurseries for dangerous insects and diseases, which, if found, must be eradicated before the nurseryman is permitted to ship his trees or plants. Certificates of inspection must accompany every package, and penalties are provided for violation of laws. In many States also orchardists are required to satisfactorily treat dangerous insect pests already established, and in a few States the sale of insect-infested fruit is prohibited. There is no doubt of the great value of these laws, and they have the active support of nurserymen and fruit growers.

There is much need of inspection of imported fruits and plants to keep out injurious species from other countries, and a movement is on foot at the present time to establish a system of quarantine under the Federal Government, and also to place the inspection of nurseries more or less under Federal control to secure needed uniformity in methods of inspection and certification. (References No. 14, p. 353; No. 62, pp. 7, 14, 30.)

DISEASES.

The diseases which the fruit grower has to combat are numerous. No plant and no part of the plant is exempt from their ravages. The portions most commonly attacked are the tender new parts where the open breathing pores of the leaves and the tender tissues of the flowers or wood afford ready means for entrance. Some diseases are perhaps not due to the presence of any special germ lodged in

the tissues, but result from physiological weakness of the plant, due probably to unfavorable surroundings. Such diseases can only be overcome by removing the cause and by improved cultural conditions.

The great majority of plant diseases are what are known as germ diseases. They are propagated by small organic bodies or spores which act as seeds in starting new growths. The life habits of these germs are often very complex. Many of them are capable of what is known as alternation of generations—that is, one generation lives on one species of plant and the next generation on a different species. For instance, apple rust (*Gymnosporangium*) lives during one generation on the foliage of the apple and the next on the red cedar, where it develops the cedar apples which produce the scarlet gelatinous fruiting bodies commonly seen on cedar trees in early summer. This disease may be largely avoided by destroying the red cedar in the vicinity. In treating plant diseases prevention is of first importance. For most of them there is no remedy after they have once entered the tissues.

Remedies.—The remedy commonly used for controlling plant diseases is to apply to the susceptible portions of the plant some anti-septic covering. Materials thus used are termed fungicides. The active fungicidal principle in most of these compounds is some salt of copper so combined with other substances as not to injure the foliage. The most commonly used and generally useful fungicide is the Bordeaux mixture, which is a combination of the salts of copper with lime and water. This material is adapted for use when the tree is in leaf. Sulphate of copper is a valuable fungicide for use when trees are dormant and bare of foliage. Potassium sulphid is also used as a fungicide.

As noxious insects and diseases are often present at the same time, it is a common practice to use an application that combines a fungicide and an insecticide. Bordeaux mixture to which has been added a small amount of Paris green is an effective remedy for apple trees that are affected with apple scab and the codling moth.

NOTE.—After discussion of the foregoing points, take up in detail the treatment of some insects of special interest in the locality where the lecture is given. Insects injurious to each plant or crop and their treatment can be discussed when the cultivation of that plant is considered. (References No. 61, pp. 5-18; 24-30, or No. 20, pp. 225-238.)

EXPERIMENT AND PRACTICE WORK, SIXTH LECTURE.

I. Control of Insect Injuries by Liquid Spraying.

Material needed.—One good hand spray pump; 1 Vermorel nozzle; 1 Bordeaux nozzle; 1 pound whale-oil soap; 5 pounds tobacco stems;

1 pound Paris green; 1 pound arsenite of lead; 1 8-quart basket. If a power spray pump can be obtained it should be brought before the class.

Exercise.—Prepare a solution of whale-oil soap in the proper proportions and apply to some tree. Prepare and apply the other insecticides mentioned. The tobacco solution should be prepared by steeping it in boiling water until it is the color of strong tea.

II. Excursion.

The object of this is to search for insects and diseases that are injurious to fruit plants in the neighborhood. If impracticable to do this, have specimens of injurious insects and diseases brought into the laboratory by the students and have them study their life histories and the best methods for controlling their ravages.

III. Dust Spraying.

Material needed.—Dust bellows; air-slaked lime; some cheap wheat flour, and a box of pyrethrum powder.

Exercise.—(a) Use the dust bellows in spraying air-slaked lime. (b) Show the proper proportions of insecticide material to use with flour or air-slaked lime. Refer to the use of this material for currant worm, codling moth, potato bug, etc.

IV. Common Insects.

Material needed.—To illustrate this lecture cases should be obtained containing a number of the most common insects. Those most useful for this purpose in one locality may not be the best for another. For most of the northern fruit sections a set may be made up as follows: Codling moth, peach borer, plum curculio, currant borer, currant worm, tent caterpillar. To these may be added specimens of the common scale insects such as the oyster-shell bark-louse, San José scale, and scurfy scale. In addition there should be specimens of plants showing injuries caused by each insect.

Exercise.—Use the material in illustrating the life histories of the various insects and require the students to make drawings of each specimen and give a good description of the insect, the injuries caused by it, and the methods of its control.

V. Plant Diseases.

Material needed.—Charts showing the life histories of the peach and plum rot (*Glæosporium*), plum pocket, peach leaf curl (*Eroacus deformans*), apple scab (*Fusicladium*), apple rust (*Gymnosporangium*), shot-hole fungus, raspberry anthracnose (*Glæosporium venetum*); fresh preserved specimens showing injuries from each disease.

Exercise.—Use the material in studying the life histories of these diseases and require the students to examine specimens under the microscope, make drawings of each specimen, describe it and prescribe remedies.

VI. Bordeaux Mixture.

Material needed.—Two 1-quart fruit jars, one 2-quart fruit jar for each student, 1 peck of best lime, and a few pounds of sulphate of copper.

Exercise.—Let each student make some Bordeaux mixture, using one-half ounce of lump lime, one-half ounce of sulphate of copper, and 1 quart of water.

SEVENTH LECTURE—HARVESTING, MARKETING, AND STORING FRUIT.

CLASSES OF FRUIT GROWERS.

The successful fruit grower must not only study how to produce fruit of superior quality and know the kinds demanded by consumers, but he must learn as well how to market it that it may bring him the largest possible returns. Markets differ greatly in their requirements and customs, and the grower who would succeed must understand the peculiarities of each.

Large fruit growers must be wholesalers, while the small grower is usually confined to doing a retail business, or at most to dealing with a jobber. The methods of distributing fruit have improved greatly in recent years. The effect has been to render the price more uniform than formerly. While this distribution interferes with the high prices that occasionally were obtained in local markets under the old conditions, on the other hand it protects the seller against extremely low prices by preventing the local market from becoming glutted. The present conditions are undoubtedly better than the old, both for the producer and the consumer.

PICKING.

The marketing of the fruit begins with the picking. This is the first step in selling it. No matter how carefully other details are attended to, the picking must be done properly or the price of the fruit will be greatly reduced. Fruit that has become too ripe or that has been roughly handled in picking must be sold at a reduced price, and often is altogether unsalable. To secure the highest prices the picking must be by hand, be done at the right time, and with the greatest care.

The precise time to pick fruit can be determined only by experience. No exact rule applying to every class of fruit can be prescribed. *Strawberries* are picked when they begin to turn red, and

raspberries when the fruit parts readily from the stem on which it grows. *Blackberries* and *dewberries* may be gathered as soon as well colored, although the flavor is improved by allowing them to remain longer on the plants. *Gooseberries* are generally marketed green. *Currants* are allowed to color, but are not allowed to ripen, and for jelly making are generally preferred while a few berries still show some green. *Cherries* are usually picked as soon as well colored, depending somewhat on the variety. *Plums* may be picked when they are well colored; the Japanese kinds, however, color well after picking. *Prunes* are usually allowed to ripen on the trees, and are shaken off if to be used for drying. If to be shipped for use when fresh they are picked as soon as well colored. *Pears* are commonly picked as soon as full grown, and are preferably ripened in the shade. It is necessary for the distant market that pears be shipped green and allowed to ripen in transit. At Fresno, Cal., the season for Bartlett pears lasts two months, the first shipments beginning as soon as the fruit is big enough to sell. *Peaches* for near-by markets are picked as soon as they begin to show a slight softness and before they become mellow. For the distant market they are picked when well colored, but still hard. Summer cooking apples are generally picked as soon as large enough to use. All *summer apples* that are to be shipped must be picked green, as they are quite perishable when ripe. Late varieties are picked as soon as well colored and before severe frost. Apples should always be picked if they show by the windfalls that they are ripening. *Winter apples* generally keep best if picked a little before they are fully colored and are still firm and hard.

The stems should be left on strawberries, plums, apples, pears, currants, and cherries. If the stems are pulled out of the fruits the injury causes rotting.

Fruit should seldom be shipped in the same package as that in which it is picked, but should be sorted into other suitable packages in a cool storehouse.

Other items to consider in picking fruit are:

Baskets and bags for picking; trays; boxes; ladders; implement pickers for the apples; methods of keeping account of pickers and packers; grades of fruit; facing; wrapping; pressing; presses for apples in barrels; presses for pears and apples in boxes; importance of marks on fruit packages; importance of keeping fruit up to grade; methods of shipping and selling; local peddling; commission dealers and associations. (References No. 14, pp. 378-401, or No. 6, pp. 43-56.)

PACKING.

Containers for fruits are many and varied, and the shipper should be familiar with them all. In some of the older fruit sections it is customary to have the boxes for small fruits returned to the packer.

This is a poor practice, as it results in the use of unsightly packages which affect the appearance and injure the sale of the fruit. The common experience of the best fruit growers is in favor of the gift package for general marketing. For distant shipments the return package is out of the question.

The various packages used in shipping fruits, with their dimensions and cost, are given in the following table from Waugh:

Kinds, dimensions, and cost of packages used in shipping fruits.

Fruit.	Package.	Cost.
Apple.....	Barrel, 100 quarts or 3 bushels.....	\$25 per 100.
	Box, various sizes.....	Variable.
	Slat crate, mostly half bushel.....	\$4.50 per 100.
	Basket, mostly bushel.....	\$1 to \$1.25 per dozen.
Peach.....	Delaware basket.....	\$2 to \$3 per 100.
	Michigan basket, $\frac{1}{2}$ bushel.....	\$3 per 100.
	Six-basket carrier.....	\$7 to \$10 per 100.
Pear.....	Barrel, 3 bushels.....	\$25 per 100.
	Half barrel, $1\frac{1}{2}$ bushels.....	\$15 to \$20 per 100.
Plum and grape.....	Boxes and baskets, various kinds.....	
	Grape basket, 10 pounds.....	\$2.50 per 100.
Cherry.....	Six-basket carrier.....	\$7 to \$10 per 100.
	Strawberry quart boxes and crates.....	Quart boxes, \$2 to \$3 per 1,000; 16-quart crates, \$5 to \$6 per 100.
Quince.....	5-pound grape baskets.....	\$3 per 100.
	Slat crate, $\frac{1}{2}$ bushel.....	\$3 per 100.
	Slat crate, $\frac{1}{2}$ bushel.....	\$4.50 per 100.
	Slat crate, 1 bushel.....	\$7 per 100.
	Baskets in various styles.....	
Berries.....	Also barrels.....	
	Quart boxes in crates.....	Quart boxes, \$2 to \$3 per 1,000; 16-quart crates, \$5 to \$6 per 100; 24-quart crates, \$7 to \$15 per 100.
	24-quart cases with boxes, gift.....	\$0.16 to \$0.18 each.
	24-pint cases with boxes, gift.....	\$0.14 to \$0.16 each.

LOCAL PEDDLING.

Local peddling is only possible where the grower lives near his customers and, where practicable, it is a very satisfactory way of disposing of the product. A variety of fruits can be carried and disposed of in this way, and besides it gives opportunity to combine truck growing with fruit growing.

THE COMMISSION DEALER.

The large grower must find some one to sell his produce. It may be best for him to sell through a commission merchant. If the grower concludes to sell in this way it is of extreme importance that the commission house that he sells to be honest. Before selecting your dealer make careful inquiry respecting his character and responsibility. The usual commission for handling fruit is 10 per cent of the gross sales.

ASSOCIATIONS OF FRUIT GROWERS.

Associations of fruit growers, when well managed, offer the most satisfactory method of selling. Here the sales are made by an agent

of the growers. Such an arrangement gives to a large number of small growers a place in the market equal to that of the big grower and shipper. It prevents their competing injuriously with one another and reduces marketing to a very simple matter. When the small grower markets through an association he can stay at home and look after the picking and packing. Organizations of this kind should have correspondents over a large territory, as they can often ignore the prices prevailing in the local markets.

GOVERNMENT INSPECTION OF FRUIT.

In Canada what is known as the Fruit Marks Act was passed in 1901. It provides for government inspection of all fruit offered for sale in closed packages, but exempts wild fruits and cranberries. Every closed package offered for sale must be marked with the name and address of the packer, the name of the variety or varieties contained in it, and the grade of fruit. The marks as to grade may consist of No. 1 or XXX, of No. 2 or XX, and No. 3 or X. The grade known as No. 1 or XXX must consist of well-grown specimens of one variety, sound and of nearly uniform size, of good color for the variety, of normal shape, and not less than 90 per cent free from scab, wormholes, bruises, and other defects and be properly packed. The penalties for violation of the provisions of this act consist of a fine not exceeding \$1, and not less than 25 cents for each and every illegal package had in possession for sale.

This act has been in force for a number of years, and there is a very general sentiment in its favor, especially in regard to fruit intended for export.

In the line of meat, butter, cheese, and some other products, our Government has improved the export business by suitable inspection, and it could probably extend its offices to the inspection of fruit to the advantage of all concerned.

STORING FRUIT.

The importance of being able to store fruit successfully is that—

- (a) It tends to prevent gluts in the market.
- (b) It gives opportunity to get far better prices.
- (c) It gives stability to prices.
- (d) It gives a chance to distribute the labors of marketing over longer time.

The essentials of fruit storing are as follows:

- (a) The fruit must be of good quality and have been carefully handled. It will seldom pay to store poor fruit.
- (b) Every grower should have facilities for keeping fruit for a short time. This may consist of cellars, caves, or sheds with double walls.
- (c) Ventilation

and temperature are the chief points to consider in keeping storage quarters at their best. Ice may sometimes be used to advantage in reducing temperature. (d) Whether the grower should own his storage house or use commercial cold storage is a point that should be carefully considered by every fruit grower. (e) The varieties which keep well in cold storage should be carefully considered by those who expect to store their fruit, as there is a great difference in their keeping qualities. (Reference No. 16, pp. 435-461.)

NOTE.—In connection with this lecture, if practicable, a visit should be made to some distributing center where commission or other dealers can be visited during the time of most active business. Visit also cold-storage warehouses. (References No. 6, pp. 95-123, or No. 14, pp. 435-461.)

For a summary of recent experiments in the cold storage of pears and peaches, see Reference No. 65, pp. 21, 22.

For apples, see Reference No. 66, pp. 63, 64.

EXPERIMENT AND PRACTICE WORK, SEVENTH LECTURE.

I. Packing Fruit.

Material needed.—A collection of forms of fruit packages; also forms of ladders for picking fruit. These might be limited to three of the most improved patterns. The collection of fruit packages should include one clean new fruit barrel with head complete; one bushel box; one gift 16-quart box crate, such as is used for packing small fruit; one 16-quart box crate, of the same kind; one pint and one quart fruit crate return package complete, and if these can be such as have had considerable service, so as to show the disadvantage of the use of such a package, so much the better; one 12-box peach crate, and if other packages are commonly used in the section where the exercise is given, they should be included; one barrel press; hammer; barrel nails; lining hoops; at least three barrels of apples of fair quality, from which can be selected one barrel No. 1 and one barrel No. 2; two $\frac{1}{2}$ -bushel swing bale baskets; one heading press.

Exercise.—Sort out one barrel of No. 1 apples and pack in the new fruit barrel in the most approved and protected way. This barrel should have a circular piece of paper to go on the head, should be faced two layers, and should be shaken down each time that a half bushel of apples is put into it. Crown the barrel properly with the fruit, put on the head, press into place, and head up in good shape the same as if the package was to be shipped. When the work is done, call the attention of the students to the fact that the fruit will not rattle in the barrel, but that the whole thing moves as one solid mass. Also note that if the barrel is slack full, the fruit is almost sure to spoil if shipped a long distance or handled roughly. It will be found best

for each student to do this work, and each operation should be criticised by both teacher and students as the work progresses. Have the students pack in boxes, crates, and baskets.

If this exercise is given in the autumn when the picking of fruit is going on, a visit should be made to some of the best orchards to note the way in which the fruit is picked. Emphasis should be laid upon the importance of proper picking and attention directed to injuries occasioned by rough handling. In sorting apples the No. 2's should be put by themselves, care being taken to illustrate what is a No. 1 and a No. 2 quality of fruit. If this lesson is given in the small-fruit season or when peaches and plums are ripening, visits to fruit plantations of these various kinds should be made.

II. Fruit Storage Warehouses.

Material needed.—One detail plan of a fruit storage house. This should be made like an ordinary building plan, drawn to a quarter-inch scale. A piece of brown drawing paper 24 inches square, a 12-inch ruler, and a lead pencil for each student.

Exercise.—Criticism of the plan of the fruit storage house exhibited before the class, and require the drawing by each student of a fruit house made on similar lines but of different sizes and suited to their several ideas. Refer specially to the importance of ventilation and how it may best be obtained.

III. Injured Fruit.

Material needed.—Fruit that has suffered from being picked at the wrong time or packed poorly; fruit that has been injured in cold storage; examples of the different defective fruits that may be on the market.

Exercise.—Have the students criticise the condition of the fruit, the value of the packages before them, and record their criticisms.

EIGHTH LECTURE—BOTANY OF CULTIVATED FRUIT PLANTS.

BUDS OF FRUIT PLANTS.

Buds are generally formed at the nodes and in the axils of leaves, but may also develop under certain conditions anywhere on the stem or root. Plums, cherries, raspberries, and blackberries thus develop buds when cut back or injured. The fruit buds of apples, pears, and European plums are usually produced on short spurs at least two years old. The peach fruit buds are borne only on the new growth formed the preceding season. Fruit buds are usually larger than leaf buds. With orchard fruits they are formed during late summer and early fall, and with a little practice can be readily distinguished in winter. In most cases the embryo flower within the bud

can be seen with the naked eye. (References No. 11, pp. 24-27; No. 16, pp. 21-40.)

LEAVES OF FRUIT PLANTS.

An abundance of healthy leaves is essential to the rapid growth of the tree and the regular development of fruit. The leaves combine and elaborate the crude sap from the soil and the carbon dioxid of the air into new compounds suitable for wood growth and fruit. Spraying, even in years of unfruitfulness, is often of advantage because it permits the maturing of a full crop of healthy leaves. (Reference No. 11, pp. 27, 28.)

FRUIT.

A true fruit, strictly speaking, is the ripened seed vessel and its contents. This agrees with the horticulturist's definition of such fruits as apples, pears, peaches, apricots, plums, gooseberries, and currants, but in the case of strawberries, blackberries, and mulberries it would permit only the single grains on the sides of the berries to be called fruits, whereas the fleshy center is the part referred to by the fruit grower when he speaks of them as fruits.

FLOWER.

The flower is the portion of the plant designed for the production of seed.

The parts of the flower and the purpose of each—

Calyx.—Made up of sepals generally green in color.

Corolla.—Made up of petals generally colored.

Stamens.—Male organs made up of filaments or stems to which are attached anthers containing pollen grains.

Pistils.—Female organs made up of the ovary or seed pod, the style or stem, and the stigma which is the part that receives and holds the pollen. (Reference No. 28, pp. 90-96.)

POLLEN.

Pollen grains vary in form, but are cell-like in structure and have the power of making a root-like growth through the tissues of the pistil to the ovary, where the pollen unites with and fertilizes the contents of the ovule. Without this process taking place, seed could not be produced and fruit is seldom formed. Pollen from one species of fruit will not fertilize the ovule of another of different, distinct species, but each is restricted in this respect to a very close limit. For instance, the pollen of one variety of the apple will fertilize other apples, but it will not fertilize the plum. When varieties of the same or nearly allied fruits are fertilized with pollen from one another they

are said to be crossed and the operation is termed crossing. The effect of this first cross is seldom well marked in the resulting fruit, although the skillful operator may sometimes be able to note the difference, but the cross does show in the seedlings from the crossed fruit. The results of such crosses are, however, quite uncertain.

Under natural conditions flowers are pollenized in various ways, but chiefly by the wind in the case of plants that have inconspicuous flowers, such as corn, pine, spruce, and poplar; and by insects as in the case of our cultivated fruits and most other plants which have conspicuous flowers. Some flowers are probably pollenized in both ways.

HYBRIDS.

Where a cross is made between very different forms, as between the sand cherry and the plum, the result is termed a hybrid. The difference between crosses and hybrids is only one of degree, and of late years there has been a tendency to do away with the use of the term "hybrid" altogether. There is a common impression that hybrids are exceedingly rare and that they are of more value than ordinary crosses, but such is far from being the case, as they are frequently of but little value.

FRUIT PLANTS FROM SEED.

While wild plants come nearly "true" from seed, cultivated fruits, which have been developed from them, do not come "true," but show a decided tendency toward the wild, inferior forms. Although an occasional seedling may be a decided improvement over the cultivated kinds, there is not one chance in a thousand of getting better fruits than those we now have by growing the seeds of these better sorts. This is due to the fact that we do not grow our fruits from seed but by grafting, budding, etc. If they were grown from seed for many generations it would undoubtedly be possible to get them to come as true to type as do our garden vegetables. Since no two plants are exactly alike, it is evident that the strongest tendency in plants must be toward dissimilarity. Some cultivated fruit plants that come most nearly true from seed are a few local varieties of the peach, the Wyant plum, and such strawberries as the Alpine and St. Anthony de Padua.

THE YEARLY ROUND OF PLANT GROWTH.

The yearly round of activity of a plant is rapid growth in the spring, during which time it is using up the store of plant food accumulated the year before. After this rapid growth has passed there follows a slower period of growth, in which the wood is said to ripen; that is, it becomes hard by reason of its cells becoming filled with starch or other plant food which is stored for use in starting growth in the spring.

When this storing process is completed growth stops. When there is warm, moist weather, late in autumn, growth sometimes starts again and a portion of this plant food is thereby changed into unstable compounds which, when exposed to freezing, results in winterkilling. Some varieties are much more liable to start in this way than others.

CIRCULATION OF SAP IN PLANTS.

This is a complicated process that is understood in only a general way. In fruit plants that have netted veined leaves the circulation is as follows:

(a) The crude sap comes up from the roots to the leaves through the sapwood.

(b) In the leaves it is digested and enters into combination with the food that the leaves take from the air and is then termed "prepared sap."

(c) The prepared sap returns to feed the plant through the cambium, which is the portion on the outside next the bark.

(d) Girdling cuts off this return flow of sap and prevents its going to feed the tissues below. (Reference No. 28, pp. 55-61.)

CLASSIFICATION OF VARIETIES.

It has been estimated that there are more than 10,000 varieties of cultivated fruits in America. In order to study these satisfactorily some method of classification is necessary. Botanists have found it convenient to group plants under the head of class, order, genus, and species. The same classification applies to the larger groups in horticulture, but the horticulturist goes further with his classification and divides his plants into varieties.

Variety.—A variety is made up of a group of individuals which differ from the rest of their species in certain recognizable particulars which are transmitted from generation to generation without material modification. Varieties having certain important traits in common are made into groups more or less definite by the horticulturist, as for instance, when he groups certain varieties of fruits or vegetables together, as Burbank potatoes, Winesap apples, etc.

New varieties of fruits are continually appearing. In the naming and describing of these new sorts there is chance for confusion by duplication of names. In order to simplify this the following rules have been adopted by the American Pomological Society:

Rule I. The originator or introducer (in the order named) has the prior right to bestow a name upon a new or unnamed fruit.

Rule II. The society reserves the right, in case of long, inappropriate, or otherwise objectionable names, to shorten, modify, or wholly

change them when they shall occur in its discussions or reports, and also to recommend such changes for general adoption.

Rule III. The name of a fruit should preferably express as far as practicable by a single word a characteristic of the variety, the name of the originator, or the place of its origin. Under no ordinary circumstances should more than a single word be employed.

Rule IV. Should the question of priority arise between different names for the same variety of fruit, other circumstances being equal, the name first publicly bestowed will be given precedence.

Rule V. To entitle a new fruit to the award or commendation of the society it must possess some valuable or desirable quality, or combination of qualities, in a higher degree than any previously known variety of its class and season.

Rule VI. A variety of fruit having been once exhibited, examined, and reported upon as a new fruit by a committee of the society will not thereafter be recognized as such, so far as subsequent reports are concerned.

EXPERIMENT AND PRACTICE WORK, EIGHTH LECTURE.

I. Fruit Flowers.

Material needed.—One or more compound microscopes with objectives magnifying to 300 diameters; one Coddington lens of good quality for each student; one mounted slide each of the pollen of pine, mallow, dandelion, corn, squash, or cucumber, and apple; one Brendel model of each of the flowers of the apple, plum, strawberry, mulberry, blackberry, and one each of the grape, showing staminate flowers, perfect flowers, and flowers with reflex stamens.

Exercise.—Require the students to examine the pollen of the different kinds of plants exhibited and to make a drawing of the form of each. If fresh pollen can be obtained use these in preference. The purpose of this is to acquaint students with the fact that there is individuality in pollen and that plants may often be as readily distinguished by their pollen as by their seeds. With the flower models describe the flowers of the fruits and call attention to the peculiarities in the structure of each and require the students to make drawings of all the models shown. If fruit flowers can be obtained they should be dissected by the class.

II. Buds and Branches.

Material needed.—Twigs of the peach, apple, plum, and currant having wood at least three years old showing flower and leaf buds; flower buds of the lilac or red berry elder, these buds being large and easily dissected.

Exercise.—Give each student a twig of each kind of fruit plant available and some of the flower and leaf buds of the lilac or elder. Direct attention to the difference between flower and fruit buds on the several specimens and to the arrangement of the leaves. Explain what is meant by the term “fruit spurs,” and have them dissect both flower and fruit buds, examine with the Coddington lens, and make drawings.

III. Hand Pollination.

Material needed.—Paper, pencils, and microscopes; plants in flower, so that each student can have at least one. Plants ready for pollination can be had at any time during the spring and summer. Later in the season cucumber, squash, or tomatoes may be used, and in winter primulas, geraniums, or any of the common indoor plants.

Exercise.—Call attention to the different parts of the flower, and have each student make drawings of each part. Note the condition of the style and anthers before the flowers open, and each day until the anthers shed their pollen. Note the condition of the style and stigma on flowers of various ages. Note when the stigma becomes moist and the condition of the anthers at this time. This occurs with some before and with others after the anthers shed their pollen. If there are squash or cucumber plants near by, note the way in which bees transfer the pollen. Have all the students make these observations and write out full description of them in their notebooks.

NINTH LECTURE—PROPAGATION OF FRUIT PLANTS.

With a few unimportant exceptions the cultivated fruits do not come true from seed, and hence other methods have been devised for their propagation.

PROPAGATION BY SEED.

(a) The seed is used in growing stocks upon which to work such fruits as apples, pears, plums, peaches, etc.

(b) The seed is also used in growing the varieties of plums, peaches, and strawberries that usually come true from seed, such as the Alpine and St. Anthony de Padua strawberry, the Wyant plum, and a number of local varieties of peach.

Germination.—Some of the conditions that influence the germination of seeds are as follows:

(a) Seeds that ripen in the early summer, such as those of the strawberry, gooseberry, and raspberry, if sown at once will germinate quickly. Seedlings of such kinds should be wintered over in a cold frame, greenhouse, or cold cellar. If the seed is dried, it should be stratified over winter and be sown in the spring.

(b) Seeds that ripen in the late summer should be stratified and sown in the late spring.

(c) Stratification is the mixing of seeds with soil or other material and burying out of doors. It is a common and very satisfactory way of keeping the seeds of peaches, plums, apricots, and various kinds of nuts over winter. All of the hardy seeds may be treated in this way successfully. Apple seed is generally dried during winter and moistened and frozen in the spring before sowing, but may be stored by stratification with best results.

PROPAGATION BY OFFSETS.

The strawberry and red raspberry, American plum, Morello cherry, and some other fruits, may be propagated by planting the sprouts that come up from the roots. Such sprouts are termed "offsets." Suckers for planting are best removed in autumn or in the spring.

PROPAGATION BY LAYERS.

The easiest and best way of propagating many ornamental as well as fruit plants is by layering. This consists in fastening a branch to the ground and covering a portion of it with earth, leaving the end free.

(a) Spring layers are made by laying down any portion of the plant early in the season.

(b) Summer layers are made in the same way, generally in July and from wood of the season's growth.

(c) Mound layering consists in heaping earth about the lower branches, allowing it to remain until after they have rooted. It is used for propagating gooseberries, currants, and quinces.

Layers may be made at any season, although roots may not form for a year, even longer, and they should be taken up when well rooted and while dormant. Layering is adapted for propagating such fruits as the grape, currant, gooseberry, and black raspberry.

PROPAGATION BY CUTTINGS.

Cuttings are portions of a plant removed for rooting and which develop into independent plants.

(a) Cuttings may be made of the ripened wood of the branches in the case of the gooseberry, currant, grape, quince, and the Kieffer pear.

(b) Cuttings may be made from roots as in case of the red raspberry, blackberry, and some kinds of cherries and plums.

(c) Cuttings may be made from the soft summer growth of the grape, currant, and gooseberry. In the case of the strawberry, they may be made from the immature offsets. Soft wood cuttings need a frame or greenhouse for securing best results.

Size of cuttings.—(a) The size of cuttings varies greatly. A single bud in each cutting is all that is required, provided the cutting is properly cared for. One-bud cuttings are frequently used in propagating the currant and grape. Both require the best of attention.

(b) Cuttings with several buds increase their chances of living and encourage strong growth.

Conditions necessary for the successful growing of hardwood cuttings.—For hardwood cuttings the wood should be well matured and firm. The wood should preferably be made up into cuttings in autumn or early winter, stored in a cold cellar, cave, or pit outdoors. They will often be calloused by spring if thus treated. The solar pit is a frame arranged so as to utilize the sun's heat in callousing the cuttings.

Planting cuttings.—(a) The soil should be rich in plant food and sufficiently compact to hold moisture but porous enough to prevent baking.

(b) Cuttings as a rule should be calloused before planting and be set out before they show roots. It is best to get cuttings into the ground as soon as it is in proper condition in the spring. Do not plant grape cuttings until they are calloused. Currant cuttings may be set out in early autumn. When thus treated they will often be rooted by winter.

(c) Do not have over 1 inch of the cutting above ground, just so that the upper bud will come at the surface.

(d) Set the cuttings at an angle of 45°. This is preferred to setting straight, as they remain more firm.

(e) In making cuttings, plan to have at least one bud within 1 inch of the top end. (References No. 11, pp. 43-59; No. 50, pp. 9-16, or No. 28, pp. 184-188, 194-202.)

GRAFTING.

Grafting is the process of inserting in a stem or branch a budding shoot from another tree or plant so that the sap may readily flow through the inner bark of both united parts.

(a) The greatest success in grafting or budding is obtained when stock and scion belong to the same botanical species or at least the same genus.

(b) Stock is the name applied to the part to which the graft is attached. The stock may consist of a cutting, a rooted layer, or a seedling root, and it may be worked when either dormant or growing.

(c) Scion is the name of the piece cut from a twig or shoot to be inserted. It may consist of one or more buds and be with or without wood.

Propagation by budding.—Budding is the name given to the operation of inserting a single bud under the bark. There is no clear dividing line between it and grafting, but in common practice the budding

is done when growth is active and the bark peels easily. Grafting is done while the growth is entirely or partially dormant, when the bark does not peel readily. In budding, one bud is used for a scion; in grafting, the scion is usually made up of more than one bud. The chief points that should be considered in discussing this subject are as follows:

(a) Bud stick is the part from which the buds are taken.

(b) Time for budding: (1) Late summer, when the buds start to grow the following year; and (2) June, when the buds start at once.

(c) Budding is done when the bark of the stock is loose and will peel.

(d) The scions are selected in fall, budding from the wood grown during the season.

(e) The budding knife should be sharp, in order to make a clean smooth cut.

(f) Methods of inserting the bud: The method most commonly employed is known as shield budding. In this method the operator removes the bud from the scion with a thin sharp knife, cutting slightly into the wood immediately under the bud. The stock is prepared by making a T-shaped incision through the bark, then loosening the bark on either side of the perpendicular cut sufficiently to permit the insertion of the bud underneath. The bud is held in place by tying lightly with some such material as raffia.

Propagation by grafting.—The chief features to be considered under the head of grafting are as follows:

(a) The cambium layers of scion and stock must be brought in contact with each other and kept there until they unite.

(b) Grafting is usually done in orchard practice when the scion and stock are both in a dormant condition. This is not necessary in grafting by approach.

(c) Grafting wax. The graft if above ground should be entirely covered with grafting wax to keep out water and the germs of diseases and prevent drying out. The top of the scion should also be covered with wax. For making grafting wax see reference No. 50, page 20.

(d) The tools commonly required in grafting large branches are a saw and a rather broad, thin chisel having a wedge-shaped prong on the end. For the smaller stocks a sharp thin-bladed knife is sufficient.

Forms of grafting.—The chief forms of grafting are as follows:

(a) Cleft grafting, adapted for general use and the best known form for large limbs.

(b) Whip grafting, used on a large scale in root grafting apples, and also for a variety of other purposes outdoors. It is especially useful with small stocks.

(c) Root grafting is the insertion of a scion on the root of the stock.

(d) Side grafting. The insertion of the scion on the side of the stock.

(e) Crown grafting. The insertion of a scion on the stock at the surface of the ground.

(f) Approach grafting. Bringing the cambium layers of stock and scion in contact while each plant retains roots and trunks. After the plants unite the scion is cut off below the graft and the stock just above the graft.

(g) There are many unusual forms of grafting. (References No. 11, pp. 66-92; No. 27, pp. 108-125; No. 50, pp. 16-23, or No. 17, pp. 73-135.)

NOTE.—Charts should be provided showing the different ways of making cuttings, of layering, grafting, budding, etc. Samples should also be exhibited to the class of actual work of this nature.

EXPERIMENT AND PRACTICE WORK, NINTH LECTURE.

I. Offsets.

Material needed.—Runners of strawberries and raspberries.

Exercise.—Call attention to the different parts. Plant in wide boxes filled with earth, or, when the season permits, in the open ground.

II. Layers.

Material needed.—Rooted layers of grape or currant, a grape cane 6 feet long to illustrate methods of making layers.

Exercise.—If practicable, do this work in some vineyard.

III. Cuttings and Planting Out.

Material needed.—Six feet of currant wood for each student suitable for cuttings and 8 feet of grape wood suitable for cuttings.

Exercise.—Make into long cuttings and plant in the open ground if practicable, or show by illustrations on a blackboard how work is done.

IV. Budding.

Material needed.—Sharp budding knife, raffia, wood with bark that peels easily. If in winter, willow twigs will do if buried in moist sand in a warm room for a week or more before using. If in summer or spring, budding is best practiced on regular stocks or the branches of trees. Scions, twigs, and also some specimens of trees that have been budded must be at hand. These may be obtained from nurseries at any time.

Exercise.—Insert the buds in the wood furnished and tie carefully in place. If plants in the open are available for this purpose, let the students do some practice budding.

V. Grafting.

Material needed.—Sixteen apple stocks two years old and twenty scions for each student; grafting wax, grafting knife, waxed cloth, or paper.

Exercise.—Four kinds of grafts should be made, and four grafts of each kind: (a) Splice graft, (b) whip graft, (c) cleft graft, and (d) side graft. Pack scions in sand and a box for storage.

VI. Grafting Wax.

Material needed.—Beeswax, resin, tallow; one 2-quart tin or iron dish for each student.

Exercise.—Grafting wax is made as follows: Melt together by weight four parts resin, two parts beeswax, one part tallow. When melted, pour into water, grease the hands, and pull until it is about the color of molasses candy. Make into balls and store for use. Such wax should be placed for a short time in warm water before being used. When grafting wax is well made it will not run in the summer nor crack in cold weather. If the wax is found to be too hard, add more tallow; if too soft, add more resin. It is used for covering the union of scion and stock and for covering the wounds of trees generally. Waxed cloth or paper is made by coating cloth or heavy manila paper with hot wax, after which it is hung up to dry. It is also used for binding grafts and covering tree wounds. When ready to use, tear or cut into long strips about one-half of an inch wide. To wrap root grafts, begin at the bottom of the graft and wind around until the wound is covered with one thickness from bottom to top. If the wax cloth does not fit tightly in all places, press between thumb and finger until it does.

VII. Grafting Clay.

Material needed.—Blue clay, cow manure, and plasterer's hair.

Exercise.—Mix material together thoroughly until it forms an even paste. Then spread on some surface where it may be allowed to dry. Attention should be called to its great adhesiveness when thoroughly dry.

TENTH LECTURE—THE APPLE.

ORIGIN AND CLASSES OF THE CULTIVATED APPLE.

(a) The true apples have descended from the *Pyrus malus* of Europe. Characteristics: Woolly twigs, calyx, and flower stems; fruit various, but always holding its calyx. The common apple of commerce comes from this species.

(b) The crab apples have descended from the *Pyrus baccata* of Europe. Characteristics: Growth smooth and more wiry than that

of the true apple; leaves narrower, thinner, and with longer stems than *Pyrus malus*; flower clusters and leaves seldom woolly; fruit small on long, wiry, slender stems; seed inclosed in hard, close-fitting hulls; calyx falls off when fruit is mature. Very few of these are cultivated. The Yellow and Red Siberian are, perhaps, of this parentage.

(c) Hybrid crabs are known to botanists as *Pyrus prunifolia*. They are undoubtedly the result of crosses between the true crabs and the larger apples. In this group are included most of the so-called crabs of commerce, such as the Transcendent, Hyslop, Sweet Russet, and Excelsior.

(d) *Pyrus coronaria* is the American crab apple. The largest or Western form has become known as *Pyrus ioensis*. This is a native of the Mississippi Valley eastward. Characteristics: Tree vigorous, young growth woolly; leaves often deeply indented; fruit green or later yellowish; aromatic, hard, bitter, keeps through the winter; resembles quince in quality, and is used, like the quince, for flavoring apple sauce and jellies. There are a few of these varieties in cultivation and among them are the Souldard and the Fluke. It does not readily cross with the cultivated apple.

Among cultivated varieties of apples we often find several that closely resemble each other in fruit, foliage, and habit. Some of these groups are as follows:

(a) The Fameuse group includes: Fameuse, Shiawassee Beauty, and McIntosh.

(b) The Duchess of Oldenburg group includes: Duchess, Borovinka, Gilbert, and Charlamoff.

(c) The Ben Davis group includes: Ben Davis, Gano, Shockley, and Black Ben Davis.

FORM OF APPLES.

Apples vary greatly in form. The parts of an apple are skin, flesh, stem, cavity, calyx, basin, core, seeds, hulls, stamens, and pistils. (References No. 12, pp. 29-34, or No. 8, pp. 34-55.)

PROPAGATION OF VARIETIES.

Apples are propagated (a) by root grafting in cellar in winter on whole or piece roots; (b) by crown grafting in the field in spring, and (c) by budding.

STOCKS FOR THE APPLE.

(a) Seedlings of vigorous, hardy sorts are commonly used in the best apple districts and little attention is paid to the source of the seed. In the Central Western States, where the winters are severe and the snowfall often scanty, much attention is paid to getting

hardy stocks. For this purpose seedlings of the hardiest kinds are sought.

(b) Seedlings of hardy hybrid crabs also are now much favored for severe locations and have given good results.

(c) Seedlings of the pure *Pyrus baccata* are of great hardiness and have come into use for severe locations, especially for the Dakotas. Some varieties do not work well on it and all kinds do best on it when budded or grafted at the crown.

(d) Dwarf apples are formed by working them on the Paradise stock, which is a dwarf apple stock much used in Europe for this purpose, but seldom used in America. It makes small trees that are adapted to training in various forms.

(e) Top working or grafting the tops of trees is practiced in some sections to change the bearing of the trees and to overcome weaknesses in the trunk of certain kinds, as the Wealthy, which, in Minnesota, is liable to canker in the crotches. Some sorts are much more productive when top worked than when merely root grafted.

SOIL.

The apple may be grown on almost any kind of land, but reaches its best development on a porous limestone soil. The trees are generally short lived on dry soils.

TREES AND PLANTING.

Select vigorous and thrifty kinds adapted to the locality. They should be grown on proper stock. The height at which the head should be formed will vary with localities but is generally best trained low. Prepare the land well. If the subsoil is too hard to prevent water from draining away, it must be broken up or tile-drained.

The proper distance between the trees varies from 20 to 40 feet, according to their locality and variety.

PRUNING.

(a) Avoid pruning as much as possible, but remove weak and awkward branches.

(b) Time to prune the smaller branches is in June, but the larger branches should be removed in autumn or in the early spring before growth starts. Pruning just as the sap starts in the spring will often cause bad wounds. All wounds over 1 inch in diameter should be painted. (Reference No. 5, pp. 35-43.)

THE FRUIT.

(a) Should be protected against injurious insects and fungus diseases by spraying.

(b) Should be thinned if too thick.

(c) Some varieties bear very young, as the Tetofsky, which will sometimes bear at four years from the graft. Other kinds are tardy bearers.

(d) Off-year bearing is desirable. Trees seldom fruit much except in alternate years. The year of bearing may be controlled. (Reference No. 4, p. 45.)

(e) Young, thrifty trees as a rule produce the best fruit. Old trees can often be renewed, or at least be improved, by heavy manuring and by pruning to shorten the younger growth and encourage a vigorous growth of new wood. Young trees should not be manured heavily until they begin to bear.

CULTIVATION.

Implements used in the orchard—

(a) Plow.

(b) Ordinary harrow or drag, but this either does not go close enough to the trees or bruises them.

(c) Disk harrow reaches under the trees.

(d) Various forms of special orchard plows and cultivators.

Harvesting, storage, and marketing. (See Lecture VII.)

USES OF THE FRUIT.

(a) Dessert and kitchen purposes.

(b) Drying.

(c) Jellies, apple butter, etc.

(d) Cider, vinegar, etc.

INSECTS COMMONLY INJURIOUS TO THE APPLE.

(a) Codling moth.

(b) Curculio.

(c) Tent caterpillar.

(d) Cankerworm.

(e) Borers.

(f) Woolly aphis.

(g) Scale insects.

For treatment of injurious insects see Lecture VI.

DISEASES COMMONLY INJURIOUS TO THE APPLE.

(a) Scab (*Venturia inæqualis*).

(b) Bitter rot (*Glomerella rufomaculans*).

(c) Black rot (*Sphæroopsis malorum*).

(d) Pear blight, twig blight, or fire blight (*Bacillus amylovorus*).

(e) Leaf blights (*Phyllosticta malorum*).

(f) Flyspeck (*Leptothyrium* sp.).

(g) Canker (*Glomerella rufomaculans*, *Sphæroopsis malorum*).

(h) Powdery mildew (*Sphærotheca mali*).

(i) Rust (*Gymnosporangium* spp.).

Read references No. 44 or No. 27, pp. 72-94; No. 4, pp. 7-69; No. 29, pp. 40-67; No. 26, pp. 237-248; or No. 19, subjects, Apples and Pomology.

EXPERIMENT AND PRACTICE WORK, TENTH LECTURE.

I. Description of Apples.

Material needed.—At least five distinct kinds of standard apples and two kinds of crab apples; one No. 2 violet aniline pencil for each student; ten sheets heavy paper with the side heads as indicated below for each student.

Form of card to be used, size $6\frac{1}{2}$ by $4\frac{1}{2}$ inches.

Size.....	
Form.....	
Color.....	
Cavity.....	
Stem.....	
Basin.....	
Calyx.....	
Stamens.....	
Flesh.....	
Flavor.....	
Seeds.....	
Core.....	
Season.....	
Tree, etc.....	
Total.....	

Exercise.—Describe each of the five standard varieties of apples and the two kinds of crabs by carefully filling in each blank space on the card with appropriate notes. With the aniline pencil mark around the edges of the apple and around the core. Then take an impression by pressing the back of the card against the apple and with a lead pencil run over the outline thus made. The filling in of the blanks will take more than an hour.

II. Apple-Growing Districts of North America.

Material needed.—One outline map of North America on common paper for each student; pencils.

Exercise.—Plat the principal apple-growing districts of North America and write in each district the standard market sorts grown in that district.

III. The Best Forms of Trees to Plant.

Material needed.—About one dozen apple trees of transplanting size and varying in form. These should include the low branching,

spreading, and upright sorts, as well as kinds having bark of strikingly different colors. A collection that would illustrate these features might be made up of the Tetofsky and Whitney as samples of upright growers, Rhode Island Greening and Hibernial of the spreading varieties, and the Yellow Transparent for its light-colored bark. Paper, ink, and pencils.

Exercise.—Let each student make a drawing or photograph of each tree before and after being pruned by the teacher. Accompanying this drawing there should be a description of the tree, giving its principal features.

If the pruning exercise is given in the orchard, which may often be done to advantage, have the students first mark the branches of the trees to be pruned with a small piece of wire bent around them. The work can then be examined by the teacher in charge before any cutting is done. By this method inexperienced students may often be put at work in a good orchard.

ELEVENTH LECTURE—PEAR AND QUINCE.

PEAR.

Origin.—The common pear of commerce is descended from the wild *Pyrus communis* of Europe and Asia. The trees of this species are usually pyramidal in shape. Von Mons, in Belgium, early in the nineteenth century, probably did more to improve the pear than any other person. He originated many of the standard kinds grown to-day.

The Japanese or sand pear (*Pyrus sinensis*) is a native of Asia. Its fruit is gritty, hard, austere, and of little importance commercially. However, it is very productive, healthy, and hardy to withstand wide extremes of temperature. The Kieffer, Le Conte, Garleer, and others have originated by combining the sand pear with the *Pyrus communis*. This cross constitutes a most important group commercially, for while the pears are inferior in quality to most of the standard sorts on the old list, the trees are exceedingly productive and the fruit is valuable for canning purposes. (Reference No. 11, pp. 167–170.)

The great interest in pear culture in recent years has led to the introduction of a large number of new varieties, until now there are about a thousand kinds described.

Propagation.—(a) Pears are propagated by crown grafting in the field; (b) by root grafting in the house in winter on whole roots; (c) by budding in summer. (See Lecture 9.)

Stocks.—The stocks commonly used for the pear are:

(a) Seedlings of the small, crabby pears, which are common in Europe and are known botanically as the *Pyrus nivalis*. These produce a large amount of plump seed, and are vigorous and thrifty.

Most of the stocks used in this country are imported from Europe, and trees worked on these grow into standard or large trees. The seedlings are not easily grown here, as they often blight in the seed bed.

(b) Quince roots (*Cydonia vulgaris*) are used as stocks for dwarf pear trees. These stocks are grown by mound layering the Angers quince, and are afterwards planted out and budded. The union formed is quite permanent, although it is often marked by a considerable swelling. Some varieties do poorly on the quince, while others are improved both in productiveness and in quality of fruit. If dwarf trees are planted deep they throw out roots above the union and become standards. Dwarf pears have the merit of fruiting very young and heavily, often when only three years from the bud. They require the new wood to be shortened each year if they are to be kept in compact form, otherwise they grow too rangy. About 12 feet is the proper planting distance.

(c) Thorns (*Cratægus*), mountain ash, and even shad bush (*Amelanchier canadensis*) have been used as stocks for the pear with fair results. It is quite common to use the mountain ash for this purpose in Sweden, where ordinary pear stalks are tender. The Japanese quince has also been tried, but does not form a permanent union.

(d) The Kieffer pear is sometimes used for pear stalks, and for this purpose it is generally grown from cuttings. Its use is largely confined to the Southern States.

Soil.—Rich, moist soil is the best. The pear needs a more fertile soil than the apple.

Trees and planting.—(a) Young, thrifty trees about two years from the bud are the best for planting.

(b) Pears are generally placed 16 by 16 or 20 by 20 feet apart, according to the form and size of the varieties.

(c) Pears bear paying crops younger than apples. This quality, however, varies much with the different kinds.

Pruning.—Pears need more pruning than apples when young. During the first few years after planting the central shoots that usually seem to attract all the growth should be pinched or shortened, except the one central shoot, which should be preserved through the life of the tree. Proper attention to this when trees are young will develop a head that will need but little training when the tree is mature.

Fruit.—The fruit varies greatly in quality. Some varieties are only valuable for cooking, and others are of finest dessert quality. In color pears vary from a beautiful yellow with pink cheek to dark, rough, deep-brown russet. In form they vary from globular through a great variety of shapes to the typical pear shape. In season of ripening they range from early summer to kinds that will keep in an ordinary cellar until March.

The fruit should be protected by spraying, and should be picked when full grown even if very hard, as it is improved by being ripened under cover. Some varieties that water core badly on the trees are exempt from it when ripened under cover. They are on the market as fresh fruit, dried, or canned, and are used for making pear cider which is known as "perry."

Varieties.—The varieties selected should be such as are recommended by the local horticultural society or by the American Pomological Society. Farmers' Bulletin No. 208, by the U. S. Department of Agriculture, offers many suggestions. Care should be taken in planting to see that the self-sterile varieties are mingled with those that are self-fertile.

Insects and diseases.—The insects and diseases commonly attacking the pear are much the same as those attacking the apple. It is more liable than the apple to fire blight. A very destructive insect enemy is the pear psylla. (References No. 4, pp. 71-77, 236, 254; No. 29, pp. 67-73; No. 26, pp. 432-451.)

QUINCE.

Origin.—The quince is a native of Asia and southeastern Europe, and is descended from the *Cydonia vulgaris*.

Propagation.—The quince is propagated—

(a) By cuttings of the new wood planted in autumn and from cuttings of the surface roots.

(b) By mound layering.

(c) By budding and grafting the cultivated varieties on the free-growing Angers quince.

(d) By grafting long quince scions on short pieces of apple roots, which are broken off after one year. This method is successful with some varieties that do not grow easily from cuttings.

The quince is also used as a stock for dwarfing pears. (Reference No. 5, pp. 108-111.)

Soil and planting.—Rich, moist, not wet soil is best.

(b) Plant about 12 by 12 feet apart.

(c) Avoid much stable manure, as it has a tendency to encourage fire blight. Maynard recommends 300 to 500 pounds of sulphate of potash and 500 to 1,000 pounds of ground bone per acre as a fertilizer.

Pruning.—Little pruning is required except to keep the suckers off the trunk and roots. The trees should branch close to the ground.

Fruit.—The fruit should be picked when it begins to turn yellow. It requires great care in handling, as it bruises easily, but will keep a month or more. It is used entirely for canning.

Insects and diseases.—The quince is attacked by nearly the same insects and diseases that affect the apple and the pear, and is espe-

cially liable to fire blight and to attacks by the flat-headed apple-tree borer. (References No. 26, pp. 518-521; No. 11, pp. 173, 174; No. 29, pp. 73-75; No. 5, pp. 55-82.)

EXPERIMENT AND PRACTICE WORK, ELEVENTH LECTURE.

I. Pears and Quinces.

Material needed.—Samples of a good typical specimen of fruit of each of the several kinds of pears and quinces. If this exercise is given when fresh fruit can not be obtained, canned specimens should be provided.

Exercise.—Make tracings, as in Lecture 10, of the pears and quinces.

II. Pears and Quinces for Planting.

Material needed.—Pear trees, one erect grower of standard 1-year-old, 2-year-old, and 3-year-old trees, and one 3-year-old dwarf pear; fifty quince cuttings; several specimens of layers used for dwarfing pears; one quince tree of transplanting size; one pair of pruning shears.

Exercise.—Students should examine pear trees of different ages to determine the manner in which the stock and scion have joined. To do this split the root of one of the trees at the union and note that the original union of stock and scion can be seen if the splitting is carefully done. One tree of each kind also should be pruned ready for setting out. Do the same with the quince if it is budded or grafted. In any case prune ready for setting out. Make drawings of the typical shapes of each of the varieties of trees shown. Call attention to the quince cuttings and layer specimens and have drawings made of each.

TWELFTH LECTURE—THE STONE FRUITS.

Under the head of stone fruits are included several well-marked groups, viz, peaches, plums, cherries, almonds, nectarines, and apricots, all of which are classified under the genus *Prunus*. This is one of the most important genera to horticulturists, and contains some very valuable fruits as well as ornamental plants. The discussion in this lecture is confined to the peach, nectarine, apricot, plum, and cherry. The almond is an important fruit which belongs in this class, but because of the fact that it is limited to the far South, methods of its cultivation are omitted.

PEACH.

Origin.—Asia. There is so much intermingling of families among cultivated peaches that they are difficult to separate. They, however, have been classified in a general way as follows:

(a) The Peen-to group or flat peaches, represented by the Peen-to variety and grown mostly in the South.

(b) The South China group, having long pointed fruits with a deep suture near the base. Example, the Honey.

(c) The Spanish or Indian group, having very late yellow, firm, and often streaked fruits; grown in the South. Examples are the Lulu and Galveston.

(d) The North China group, having very large fruits and leaves and clingstone fruit. Represented by the Elberta and Smock.

(e) The Persian group, the common peach of the North. This group includes the Crawford, Salway, Old Mixon, and others.

Propagation.—The peach is propagated as follows:

(a) Seed. Some varieties of the peach come so nearly true from seed that they are thus propagated, but it is an uncommon method with commercial varieties.

(b) Budding is the common and almost the exclusive method in practice in the North. (See Lecture 9.)

(c) Grafting the peach is practiced in California and in the South.

(d) Peach seed must be stratified over winter. It should be examined before planting in the spring and those pits that are not cracked by frost should be broken by a hammer.

Stocks.—(a) Seedlings from natural fruit are preferred, i. e., those which have not been worked and from sections where the peach is healthy and free from yellows. A favorite source of peach stock is in parts of Tennessee and Kentucky where the peach grows in thickets.

(b) Plum stocks are sometimes used for the peach where it is grown in heavy moist soil, but is seldom used in commercial peach growing.

(c) The peach buds easily. The seedlings should be worked the first season, when they will be 18 to 24 inches high. If the stock is larger, the buds will grow too large the first year.

Trees for planting.—(a) Small, not weak, trees 1 year old from the bud are best for planting out. They should be trimmed to a straight shoot 1 to 3 feet high. This facilitates forming the head.

(b) Trees more than one year old at planting seldom make good bearing trees.

Planting in orchard.—(a) In the North planting should be done in the early spring or on mild days in the latter part of winter. In the South and in mild climates general planting may be done in autumn or even in winter.

(b) The distance apart will vary with the locality, soil, and variety; 15 by 15 feet apart is about the right distance for common varieties. They may be closer if when they become large enough to crowd each other the rows are thinned. Under favorable conditions two crops of fruit may be harvested before thinning is necessary.

Pruning.—This is done—

(a) To form the head.

(b) To thin out the fruit buds and prevent the branches from becoming too long and breaking down. The trees should be severely cut back each year, cutting off one-third to one-half of the new growth.

(c) When trees have been severely injured by the winter they recover most quickly when cut back to vigorous wood.

Location and soil.—(a) The peach does well even in poor soil. In very rich ground it is liable to continue its growth late in the autumn and the buds consequently are liable to kill back in winter. Some of the best orchards are on very poor soil.

(b) The peach does best on high ridges with a northern or western exposure. On southern slopes the fruit buds are liable to start too early.

(c) Other locations adapted to peach growing are where late spring and early autumn frosts are prevented by proximity to large bodies of water, as, for instance, on the lake shores in New York and Michigan.

(d) The peach districts of America are outlined in Farmers' Bulletin No. 208 by the United States Department of Agriculture. As the northern limits of peach growing are approached greater skill is required to grow them.

(e) For protection of trees from frosts in winter and late spring see Lecture 7.

Fruit.—If the trees fruit at all they generally set too much, and if all are allowed to grow the trees are weakened and the fruit is small and poor. If the directions given for pruning are followed, many fruit buds will be removed and the crop will thus be thinned. Trees that have their fruit thinned generally yield as much in quantity and are of much better quality than trees not thinned. Thinning, therefore, is most important. If pruning is carefully attended to, overfruiting is partially prevented. All curculio-stung and imperfect fruit should be removed, as they are of no value. Special thinning is needed in addition if the best results are to be secured, and this should be done as soon as the fruit is sufficiently developed to enable the grower to discover that which is imperfect. Thin to from 4 to 6 inches between the fruits. Such thinning will seem excessive at the time it is done, but the wisdom of it will be justified by the results.

Peach trees bear early, not infrequently at 2 years old.

The fruit is used fresh, and also for canning, drying, and for a kind of cider which yields brandy by distillation.

Insects and diseases.—The trunk of the peach tree is frequently injured by the peach borer and the fruit by the curculio. (Reference No. 4, p. 238.)

The diseases of the peach are as follows:

- (a) Brown rot (*Sclerotinia fructigena*).
- (b) Leaf curl (*Exoascus deformans*).
- (c) Scab (*Cladosporium carpophilum*).
- (d) Pustular spot (*Helminthosporium carpophilum*).
- (e) Yellows.
- (f) Rosette.
- (g) Little peach. (Reference No. 61, p. 20.)

Varieties.—There are many varieties of the peach. Growers must study the conditions in their own localities and the adaptation of varieties to them. (For descriptions of varieties see reference No. 12, pp. 335–360. Read also reference No. 38, pp. 5–23.)

NECTARINE.

The nectarine is a smooth-skinned peach. It is interesting to know that peaches have been grown from the seed of nectarines and nectarines from the seed of peaches. The fruit is usually inferior to that of the peach in size, quality, and appearance. It is grown the same as the peach but not nearly as successfully. It seems to do best in the Pacific coast States.

PLUM.

Origin.—(a) Europe has given us plums of the *Prunus domestica* class, such as the Lombard, Quackenboss, Green Gage, Yellow Egg, the prunes, and others of the older lists. They do best in the Eastern and Pacific coast States. The fruit of this group is subject to rot and shot-hole fungus. The trees need the best of cultivation.

(b) Some varieties of great value have come from native American species. These are largely from the *Prunus hortulana*, *Prunus chicensis*, and *Prunus americana* species. Among these varieties are Wildgoose, Surprise, and Wyant. This group is especially adapted to the great inland continental plain and promises to furnish much better sorts than we have hitherto obtained from it. Of all the plums this is the hardiest group, but does not fruit well in the East.

(c) Japan has furnished a large number of valuable sorts. They are derived from the wild plum *Prunus triflora*. They cross easily with others and often improve them. In many sections they flower too early and are also subject to disease. Among the Japanese kinds are Burbank, Abundance, and Red June.

(d) China has given us *Prunus simoni*, or the apricot plum, which is occasionally grown in this country.

(e) Hybrids have been made of most, if not all, of these distinct varieties. (Reference No. 4, pp. 95-97.)

Propagation.—Propagation is accomplished—

(a) By cuttings of the roots in the case of some of the American sorts that sprout readily.

(b) By suckers in the case of some of the American sorts; a favorite method.

(c) By budding and grafting the same as for the peach. Crown grafting at the surface of the ground is a common practice with native kinds. Root grafting in winter on whole roots is also successful but not as reliable as crown grafting early in the spring. (See Lecture 9).

Stocks.—The stocks commonly used for the plum are:

(a) The Myrobalan stock, a wild European species. It is of no practical value as a fruit. This stock is most generally used and is grown from seed.

(b) The Mariana is nearly allied to the Myrobalan. This is an American variety that can be grown from cuttings in the Southern States and makes a good general stock for plums.

(c) Peach seedlings are often used for plums, with which they make a good union, but they should not be used at the far north, as they are liable to kill out in severe winters.

(d) Seedlings of *Prunus americana* are best for the American sorts when grown in severe locations.

(e) Other seedlings of the plum are also used. The apricot has been used as a stock but does not make a permanent union.

Soils.—Plums grow on a great variety of soils, but prefer one that is rich, moist, and well drained.

Trees and planting.—(a) One or two year old trees are the best for planting.

(b) Plum trees should be set about 16 by 16 feet apart.

(c) The flowers of many plums, especially of the native and Japanese sorts, are self-sterile, hence varieties should be mixed in planting.

Fruit.—(a) The fruit, if to be shipped, should be picked when still hard, as most kinds when ripe are quite perishable.

(b) Plums are either clings or freestone. They are used fresh from the trees, dried, or canned.

(c) The term "prune" is applied to any plum that dries readily, but more particularly to plums containing over 12 per cent of sugar. This is about the amount that a good dried plum ought to contain.

(d) Thinning the fruit is practiced by the best growers.

(e) The Japanese plums fruit very early and the American and European sorts fruit in from three to six years. (Reference No. 7, pp. 42-48.)

Varieties.—There are many varieties. (Reference No. 12, pp. 291–329. See also Varieties, in reference No. 7.)

Insects.—(a) The plum curculio is the most destructive of the insects attacking the plum.

(b) The plum borer is also occasionally very injurious.

Diseases.—The common diseases of the plum are:

(a) Brown rot (*Sclerotinia fructigena*). This affects all classes of plums, as well as peaches and cherries.

(b) Black knot (*Plowrightia morbosa*), causing black bunchy growth in the branches.

(c) Leaf blight (*Cylindrosporium padi*).

(d) Yellows.

(e) Rosette.

(f) Little peach.

(g) Shot-hole leaf fungus is especially injurious to plums of the Domestica class.

(h) Plum pocket causes the fruit to become hollow and on some varieties causes the foliage and new growth to become swollen and curled up. (Reference No. 48, p. 21.)

APRICOTS.

Apricots are grown in much the same way as the plum and peach, but are more liable to injury from climatic troubles and diseases. They do best in some of the Pacific coast States. (Reference No. 32, pp. 200–210.)

CHERRY.

Origin.—Eastern Asia. The cultivated kinds probably came from two species known botanically as *Prunus avium* and *Prunus cerasus*, but during the centuries that have elapsed while they have been under cultivation they have been crossed and recrossed until it is impossible to separate the varieties into their species.

The cultivated sorts are divided for convenience into two classes:

(a) Kinds having sweet juice, including what are known as Mazzard, Hearts, and Bazella cherries. These varieties are generally tall and erect-growing trees.

(b) Kinds having sour or subacid juice, including what are known as Sour, Morello, and Early Richmond cherries. These trees are usually low headed, with spreading branches.

Prunus mahaleb is a small, slender tree, bearing small, dark red, austere fruit, and is a native of southern Europe. It is used for stocks upon which cherries are propagated.

The wild American cherries include *Prunus besseyi*, *Prunus demissa*, and a number of others. They are of little importance commercially, although where found in large quantities they are used locally.

Propagation.—The cherry is usually propagated by budding, but grafting is occasionally practiced.

Stocks.—The Mazzard and Mahaleb cherry stocks are commonly used in the propagation of the cherry, but both kinds of stocks are used for each of the classes. For severe locations, especially for sour cherries, the Mahaleb is preferred, while for sweet cherries the Mazzard is usually selected. (References No. 4, pp. 103–107; No. 26, pp. 311–327.)

For cultivation, harvesting, etc., see references.

Such other matters relating to the cherry as planting, fertilizing, pruning, cultivation, harvesting, insects, diseases, etc., will be found in the references for reading.

EXPERIMENT AND PRACTICE WORK, TWELFTH LECTURE

I. Peach Leaf Curl and Plum Pocket and their Prevention.

Material needed.—Specimens of these diseases in glass jars, so that they can be seen without the necessity of opening the jars. If fresh material can be obtained it will be more satisfactory.

Four pounds lime.

Four pounds sulphate of copper.

One oil barrel.

Two 12-quart kegs or other wooden vessels.

One barrel of water.

One copper or brass sieve at least 8 inches in diameter.

Exercise.—Slake the lime in a keg, using 8 quarts of water. Dissolve the sulphate of copper in 8 quarts of water in another keg. Put 45 gallons of water in the oil barrel and pour the copper solution and the milk of lime into it, stirring at the same time. Strain this through the brass sieve and it is ready for use. While the work of making the Bordeaux mixture is going on, the teacher should explain the life history of the diseases to be treated.

II. Written Exercise.

Material needed.—Specimens of plum or peach affected by brown rot; specimens of plum knot; plum pocket or peach foliage affected by shot-hole fungus; curculio and peach borers, with specimens of the injury done by each; paper and pencil for each student.

Exercise.—Make outline drawing of at least one disease and of one injurious insect, and give their life history and best methods of treatment.

III. Identifying Plums by their Pits.

Material needed.—A collection of six pits of each of twenty-five named varieties of plums put up in screw-cap 4-ounce jars; specimens of at least four kinds of plums grown in the section where the

exercise is given. Where specimens can not be had in fresh condition dried fruits may be used or such as have been preserved in formaldehyde. Enough should be provided to supply a specimen of each variety to each member of the class.

Exercise.—Give each student a plum; have him describe it; clean the pit thoroughly, and then compare the pit with those in the bottles and note the resemblance. Bring out the fact that plums are most accurately identified by their pits.

IV. Stratifying Peach Pits.

Material needed.—One bushel peach pits; loose dry soil; spades or shovels.

Exercise.—On a level place free from grass and from which the water drains away easily, make a bed of peach pits, 2 feet square and 2 inches thick; put on 2 inches of good fine soil and then another layer of pits; repeat until all the pits are used; then cover all with inverted sods.

THIRTEENTH LECTURE—THE GRAPE.

ORIGIN.

There are about twenty species of wild grapes in America. Few of them, however, have been fully tested under cultivation. The grapes commonly grown in this country east of the Rocky Mountains are of native origin, but in the Pacific coast States a number of European varieties are grown in great perfection. Some points of interest in this connection are grouped under the following heads:

(a) Several varieties of the European wine and table grapes (*Vitis vinifera*) do well in California and adjoining States but fail in the Eastern States. Among these are the Tokay, Sultana, and Muscat.

(b) The best table grapes of the Eastern States have originated from the native Fox grape (*Vitis labrusca*). Of these the Concord is the most widely and generally grown.

(c) Hybrids of the above-mentioned species exist in large numbers. It has been found that the presence of any considerable amount of the European wine grape in any variety usually causes a corresponding loss in hardiness. The Rogers hybrids are examples of this.

(d) The *Vitis riparia* or the River Bank grape of the North crossed with the *Vitis labrusca* has furnished a few extremely hardy kinds, as the Janesville and Beta. These are a great improvement over the original River Bank variety.

(e) In the South there are other species that have produced good merchantable varieties. Many of these appear to be better adapted to the warm climate of the Southern States than the kinds that have come from northern stock. (Reference No. 46, pp. 12-15.)

PROPAGATION.

The grape is propagated—

- (a) By cuttings; most common.
- (b) By spring and summer layers. Each bud on a summer layer may be made to produce a new vine by layering. (See Lecture No. 9.)
- (c) By grafting; to strengthen weak vines and to render the European grapes immune from the grape root louse (*Phylloxera*). This method is used in California and in France and Germany wherever the European grape is grown and the American grape root louse has been introduced. Our native *Vitis riparia* is used as stock and is proof against the attacks of the root louse.

LOCATION.

The grape likes a warm location.

- (a) High land sloping to the south generally preferred.
- (b) On sloping land about lakes and rivers. In such locations southern slopes are preferable, but the northern often gives equally good results.
- (c) The grape needs a free circulation of air. In close situations it is liable to disease.

SOILS.

The best soil for the grape is an open, porous clay, but it often does well on a gravelly loam. Limestone soils and loess loam are especially adapted to it.

VINES AND PLANTING.

- (a) The best vines for planting are strong, one-year-old plants with abundance of roots.
- (b) When planting, the vine should be cut back to about two buds and the roots to about 1 foot in length.
- (c) The plants should be set about 8 by 10 feet apart. Weak growers may be planted somewhat closer. It is a good plan to furrow out one way with a plow and to merely mark out the other and set the vines at the intersections.
- (d) Close planting prevents circulation of air and encourages disease.
- (e) In the best grape regions the vines are set only a little deeper than they grew in the nursery. In severe locations, especially on gravelly soils, they should be set at least 12 inches deeper than they grew in the nursery, to prevent root killing.

MANURING.

(a) Grapes generally do best without much in the way of nitrogenous manures, but on very gravelly soil stable manure may sometimes be used to good advantage.

(b) The best way of keeping up the vineyard is by the use of moderate amounts of potash, phosphoric acid, and cover crops. Unleached hardwood ashes is a good fertilizer.

(c) The grape should be encouraged to make only a moderate amount of growth, as a very strong growth is not desirable.

CULTIVATION.

(a) For the first two years some hoed crop may be grown among the vines.

(b) After the vineyard commences to bear no crops should be grown in it, but the surface of the soil should be kept well stirred so as to form a dust blanket.

(c) If the vineyard is plowed over each spring it will keep the roots from coming too near the surface, but this practice must commence when the vines are young or it will be injurious.

SUPPORTS AND TRELLISES.

It is customary to let the vines trail naturally on the ground without support the first year and put up a trellis the second year. The kind of trellis to be used will depend largely on the system adopted for training and pruning the vines.

TRAINING AND PRUNING THE VINES.

(a) The European wine grape is commonly grown in California without any trellis, but is severely cut back to the old stumps each year.

(b) The systems of training used in growing American grapes are various. The points to be observed in training and pruning are as follows:

(1) The old wood which has borne fruit never bears again.

(2) The wood that is formed one season produces the bearing wood of the next.

(3) If all of the new wood is left on the vine, it will bear many times more clusters than it can properly develop, and they will be small and imperfect.

(4) If nine-tenths of the bearing wood is cut away, leaving only from three to six buds to each cane, the yield of perfect fruit will be much increased.

(5) In severe climates the vines should be trained so that they can be laid on the ground with but little resistance, for in such locations it is necessary to protect them during the winter.

(c) The Kniffen system is the most satisfactory for general use.

(d) The Munson system originated with Prof. T. V. Munson. It is based on the belief that the native American grape fruits best when the sap comes through a long piece of old wood.

(e) Old vines that are in bad shape may be cut off close to the ground in late winter or early spring and a new vine formed from the sprouts. (Reference No. 4, pp. 120-125.)

FRUIT.

(a) The fruit, if it sets well, must be thinned.

(b) Seven thousand pounds per acre is a good yield, but heavier yields often occur.

(c) Grapes must ripen on the vine or the fruit will be of poor quality. It does not ripen after being picked.

(d) The fruit must be carefully handled.

(e) Grapes keep well in cold storage.

(f) Bagging the fruit to protect it from diseases, insects, and frosts is practiced successfully.

(g) Girdling the vine increases the size and earliness of the grape. (Reference No. 16, pp. 284-297.)

VARIETIES.

Some varieties of grapes have weak or sterile pollen. Among these are the Brighton, Lindley, and Wilder. Others with fertile, strong pollen are the Concord, Worden, and Jamesville. (For description of varieties, see reference No. 12, pp. 370-395.)

INSECTS AND DISEASES.

Of the insects affecting the grape the root louse, berry moth, leaf hopper, flea beetle, and rose bug are the most injurious.

The common diseases of the grape are:

(a) Black rot (*Guignardia bidwelli*).

(b) Anthracnose (*Sphaceloma ampelinum*).

(c) Downy mildew or brown rot (*Plasmopara viticola*).

(d) Powdery mildew (*Uncinula necator*). (Reference No. 48, p. 22.)

References No. 4, pp. 114-129; No. 29, pp. 126-146; No. 11, pp. 228-250; No. 49, pp. 3-22; No. 19, subject, Grapes. For the manufacture of grape juice see reference No. 52.

EXPERIMENT AND PRACTICE WORK, THIRTEENTH LECTURE.

I. Pruning Grapes.

Material needed.—This exercise is best given in some vineyard where the prevailing system of pruning may be discussed and its advantages and disadvantages noted. Where this is not practicable a vine about 8 feet long trained on a trellis can be used in the class room. If a whole vine can not be obtained for this purpose, a large old cane may often be trained into such form that it will show the principles of pruning very well. This trellis should be mounted on a piece of plank so that it can be readily handled. One pair of pruning shears should be provided if the work is done with a miniature trellis. If done in a vineyard, there should be one pair for each student. Six one-year-old and six two-year-old grapevines should also be provided. If the exercise is given when the ground is frozen, use a box 4 by 4 feet by 18 inches filled with soil for transplanting.

Exercise.—Select some simple method of pruning adapted to the location and explain it to the class by means of a diagram on the blackboard. Do this before taking the students into the vineyard or before pruning the vine on the miniature trellis. Make clear what is meant by the terms "fruit spur" and "bearing wood." Show where the fruit is borne on the vine and also how to layer grapevines. Set out the small plants in the open ground if conditions are such that this can be done and prune them for the first year. If facilities are not available for this purpose, show the class how the vines go in the ground and have the students prune both tops and roots and use the box of soil to illustrate transplanting.

II. Protecting Grapes by Means of Bags.

Material needed.—Twenty bags and paper of pins. It will be difficult to give a satisfactory demonstration of the method in the class room.

Exercise.—Protect 20 grape clusters with bags well pinned on.

III. Girdling Grapes.

Material needed.—One growing grapevine, a small knife or special tool for girdling grapes.

Exercise.—Have the students girdle a few bearing lateral canes and explain how this does not permanently injure the vine since these canes are cut away at pruning time. Explain the principle of the increase of the size of the fruit due to girdling. If growing vines are not available, this subject may be taught by the usual diagrams.

IV. Making Cuttings of Grapes.

Material needed.—Plenty of ripe grape wood, a knife, and greenhouse flats.

Exercise.—Each student to make ten long cuttings and ten one-eye cuttings. Plant out the long cuttings in open ground. Plant the one-eye cuttings in boxes.

V. Layering the Grape.

Material needed.—Several thrifty vines, a spade, and a knife.

Exercise.—Layer the vines so as to secure one plant from each bud if in the spring. If work is done in the summer, make the ordinary summer layer.

FOURTEENTH LECTURE—SMALL FRUITS.

The growing of small fruits has become an important branch of our agricultural industry. The kinds referred to in this lecture are the raspberry, blackberry, and dewberry, of the genus *Rubus*; currants and gooseberries, of the genus *Ribes*, and the cultivated strawberry.

THE RASPBERRY.

Classes.—(a) The European raspberry (*Rubus idaeus*). Varieties of this class were for many years the only kinds grown in this country. They proved, however, to be poorly adapted to our conditions, although in a few localities—as, for instance, near the Hudson River—they were a success. The Herstine, Hudson River, Red Antwerp, and Superlative are representatives of this class.

(b) The American raspberries are the foundation of commercial raspberry growing in the United States. They embrace the red raspberry (*Rubus strigosus*) and the black-cap varieties (*Rubus occidentalis*). The Cuthbert, King, and Turner are of the red, and the Gregg, Older, and Ohio of the black-cap varieties.

(c) Hybrids of the red and black caps are common. They were once regarded as a separate species and were named *Rubus neglectus*. Examples are the Columbian, Schaeffer, and Philadelphia.

All raspberries in cultivation are divided into two classes: (1) Those that increase by tip layers, and (2) those that propagate by suckers. This is not a strictly botanical classification, but has been adopted for convenience.

Propagation.—The methods of propagation vary greatly with the different species. All may be grown from seed but do not come “true.” In practice the following methods are commonly used:

(a) The red raspberry may be grown from suckers.

(b) Root cuttings are also used for propagating the red raspberry and some of its hybrids.

(c) Tip layers are used for the black-cap varieties and its hybrids.

(d) All kinds may be propagated by divisions of the stocks.

Soil and location.—A cool location and a retentive soil are best for the raspberry. It is very liable to injury from hot sunny weather and drying winds, hence northern are better than southern slopes, and eastern better than western. The red varieties are better than the black for the South, while in dry northern sections the black caps succeed better than the red. Protection from drying winds is desirable, and it is frequently necessary to use wind-breaks for this purpose. (Reference No. 25, pp. 3 and 4.)

Planting and training.—(a) Varieties selected for planting should be such as are adapted to the location and to the special purpose for which they are grown. Much depends upon the judgment of the grower in selecting a variety suited to his conditions and in buying strong, healthy sets for planting.

(b) Plant about 4 by 7 feet apart. This, however, depends upon the kind of raspberries grown.

(c) Red raspberries may be planted either in the autumn or spring. If black-cap varieties are set in the autumn, the work must be done with great care and the plants be protected with mulch in the winter. As a rule they should only be planted in the spring. (Reference No. 21, pp. 7-9.)

(d) Suckering raspberries should be planted a little deeper than they grew. Cap sorts should be planted at the same depth that they grew. (Reference No. 21, p. 11.)

(e) In growing extensively trellises are seldom used, but in small gardens they are often advantageous.

(f) The canes grow one year, and fruit the next. The old canes should be cut out and burned as soon as they are done fruiting. A hooked knife is generally used for this purpose. (Reference No. 21, p. 17.)

(g) When growth starts in the spring, all but four or five young canes of each plant should be cut out. If more are left they often become top crowded. The extent to which the thinning of the canes should be carried depends largely upon the kinds grown. (Reference No. 21, p. 18.)

(h) Spring pruning consists in shortening the lateral branches from one-third to one-half of their growth. Much more severe pruning is needed in the case of black caps than with red raspberries.

(i) Summer pruning consists in pinching off the new growth when the canes are about 2 feet high. When the canes are covered in winter, this pinching should be done but once; where they are not covered the pinching off should be repeated to make the plants stocky. For summer pruning, sheep shears or a sharp knife is best.

Cultivation.—(a) Hoed crops may be used the first year between the plants to advantage.

(b) The cultivation should be shallow and continuous throughout the season.

(c) Mulching is sometimes practiced, but it is seldom that good mulching material is sufficiently abundant to make its use practicable upon a large scale. A satisfactory method is to cultivate until the fruit commences to ripen and then mulch for 2 feet around the bushes, leaving the remaining 3 feet to continue to be cultivated. After picking remove all old canes and cultivate.

(d) The tools used in cultivating raspberries are much the same as those in general use in gardens, and consist of the one-horse plow, the garden cultivator, and the hoe. An attachment for cutting suckers is sometimes put on the cultivator.

Fertilizers.—Stable manure is generally most desired for raspberries. If commercial fertilizers are used ground bone and nitrate of potash are as good as anything, and may be applied at the rate of 300 pounds of ground bone and 100 pounds of nitrate of potash per acre. (Reference No. 21, p. 7.)

Winter protection.—(a) In severe locations the canes must be laid on the ground and be protected in winter. In such places they should be pinched back but once for, if pinched frequently, the canes become too strong to lay down. Some of the best raspberry growers do not pinch back at all if they intend to lay the canes on the ground in winter.

(b) A machine has been originated in Minnesota that covers raspberries and blackberries successfully, requiring four horses to operate it. It is there used on a large scale.

(c) The proper time to raise covered canes in the spring will depend upon circumstances. They need not be uncovered until late, and may thus be held back to escape injury from late frosts.

(d) In laying raspberries it is important that the work be done before the severe frosts of autumn. The bending should be in the roots and as little as possible in the stems.

(e) Trellises for raspberries are often used to advantage in gardens and in locations much exposed to the wind. For use on a large scale the best form is two wires stretched one on each side of the row and fastened to posts at each end and then tied together at intervals with twine. The wires should be about 2 feet from the ground. Such a trellis allows the plants to sway in the wind, and at the same time prevents them from breaking and keeps them out of the way of the cultivator.

The fruit.—The fruit is red or yellow in color in the red raspberry class, and black, yellow, and purple in the cap class. The varieties vary in fruitfulness, vigor, size, and color of fruit. The red kinds are

the most popular, but black caps are much used. The purple varieties do not sell well in most markets, and are therefore grown chiefly for home use.

Picking and marketing.—Do not pick when the fruit is wet, and be particular to pick clean. Store in a cool shady place, and transport in a good spring wagon. The management of the pickers is a very important matter. The ticket system is found to be the most satisfactory. Red raspberries are generally marketed in pint boxes, and black caps in quart boxes. In the West only the gift package is used, but in the Eastern States the return package is the custom. The selecting of the kind of package best to be used should receive most careful consideration by the grower. (Reference No. 21, pp. 32-35.)

Diseases and insects.—Among the more important diseases are anthracnose, leaf curl, and red rust.

The most common insects are the stem borer and leaf-eating insects. (Reference No. 60, pp. 11-21.)

THE BLACKBERRY.

Cultivated blackberries are grouped under five heads, as follows:

(a) The high bush of the clearings and fence rows of the Northern States, with long clusters, as those of the Ancient Briton.

(b) The type with lower growth and short clusters, as those of the Snyder. Both of these groups are probably forms of the *Rubus villosus*.

(c) Trailing dewberries, as the Lucretia and Austin, known botanically as *Rubus canadensis*.

(d) Forms that are intermediate between these species are probably hybrids of the two species just referred to. The Wilson and Rathburn are of this class.

(e) The cut-leaved or evergreen blackberry (*Rubus laciniatus*), which is probably a form of the European blackberry (*Rubus fruticosus*). This variety is cultivated on the Pacific coast, where it remains green all winter and is very prolific.

Propagation.—(a) The high bush blackberry is propagated by suckers and root cuttings.

(b) The dewberry is propagated by layers.

Soils.—(a) The best soil for the high bush blackberry is a heavy clay loam, but it grows well on a wide range of soils.

(b) The dewberry is best adapted to a warm sandy or gravelly soil, but even under best conditions is not nearly as reliable a bearer as the blackberry.

Planting, cultivation, and pruning.—(a) Plant and cultivate the same as for the suckering raspberry.

(b) It is important to pinch the high bush blackberry canes at least once when 2 feet high, as this encourages the low setting of the fruit buds.

(c) Spring pruning should not be done until the canes are in flower and the amount and location of bloom are seen. As a rule about one-half of the bloom should be cut off in the pruning.

(d) It is desirable to have a trellis for blackberries and dewberries.

CURRENT AND GOOSEBERRY.

Origin.—(a) The red currant has descended from *Ribes rubrum* of Europe and America. Examples are Red Dutch and White Grape.

(b) The black garden currant is the *Ribes nigrum* of Europe. Examples are Black Naples and Lee Prolific.

(c) The Crandall is the *Ribes aureum* of western America which is practically the only form of this variety, but it varies greatly when grown from seed.

(d) The American gooseberry has come from the *Ribes oxycanthoides* of America. Examples are the Houghton and Downing.

(e) The European gooseberry is *Ribes grossularia*. Examples are the Industry and Triumph. They are not much grown in America, as they are subject to mildew.

Propagation.—(a) Currants are grown from hardwood cuttings. Nearly all kinds may be propagated in this way, but some varieties do best from layers. Cuttings should be made in the early autumn and if planted out at once will be rooted by winter. (Reference No. 21, pp. 341-343.)

(b) The American gooseberries seldom do well from cuttings and are consequently chiefly grown by layering the branches in the summer and autumn, then separating them and planting out like cuttings for one season. (Reference No. 21, pp. 360, 361.)

(c) Occasionally currants and gooseberries are grown by grafting to make what are called tree gooseberries and currants. Tree currants are also grown by pruning off all laterals.

(d) New varieties are grown from seed.

(e) Currants and gooseberries may also be grown from suckers.

Soil and location.—Currants and gooseberries do well on any soil adapted to agricultural crops, but prefer a cool location and a retentive soil. They do not prosper in hot climates.

Plants and planting.—(a) Thrifty one-year-old plants from cuttings or layers are best for starting new plantations.

(b) They may be planted out in autumn or spring, and should be set deeper than they grew in the nursery.

(c) On inferior land currants and gooseberries of the weaker-growing varieties may be planted as near as 4 by 4 feet, and some sorts may also be planted as close on rich soil. The strong-growing kinds, such as the Red Dutch and White Grape currants and the Downing gooseberry, should always be planted 5 by 5 feet, and often 6 by 6 is not too far. (Reference No. 21, pp. 344, 345.)

(d) Some hoed crop may be grown between the plants without disadvantage the first year.

Cultivation.—The surface soil should be well stirred and heavily manured. Mulching may be practiced with these fruits to better advantage than with any other.

Pruning.—(a) Pruning is done to renew the old and weak wood and to improve the size of the fruit.

(b) To get increased size in gooseberries the American sorts should have about one-half of the new growth removed each year.

(c) To get rid of borers.

(d) Pruning should be done when the plants are dormant.

Fruit.—The fruit varies much, both as to the size of each individual fruit and in the size of the bunches. The color of currants may be red, white, black, or purple. The color of gooseberries varies from a pale green to a deep red when ripe.

Picking and marketing.—The currant is not as liable to injury in picking as most other small fruits, but it requires, nevertheless, considerable care to secure best results. Currants are generally preferred for jelly when a few green berries show on each bunch of fruit. For table desert use they should be fully ripened and of the largest size.

They are generally marketed in quart boxes, but in some sections nine-pound baskets are preferred. The fairest method of marketing the fruit is by the pound. Gooseberries are most in demand when fully grown but perfectly green.

Insects and diseases.—Among the common insects affecting these plants are the currant worm, currant borer, leaf lice, and berry moth.

The more common diseases of the currant and gooseberry are leaf spot and mildew.

Winter protection.—(a) Winter protection is sometimes given by covering the branches of gooseberry bushes with earth or by laying them on the ground and covering with mulch.

(b) By tying the tops of currants closely together for the winter. This prevents breakage by snow crusts, ice, etc.

EXPERIMENT AND PRACTICE WORK—FOURTEENTH LECTURE.

I. Pruning Small Fruits.

Material needed.—Three large old plants each of black raspberry, gooseberry, currant, dewberry, and blackberry with all the old canes on them; one pair pruning shears; samples of fruit of each kind; one pint of each preserved in a 2 per cent solution of formaldehyd.

Exercise.—Call on the different members of the class to describe each class of fruits and give the peculiarities of each. Select members of the class to prune the bushes under the direction of the class and teacher. Call attention to the biennial character of the canes of the

raspberry and blackberry and the perennial character of the stems of currants and gooseberry plants. In pruning the currant, call attention to any work of the currant borer that may appear and refer to its life history and to the importance of burning the trimmings.

Note.—If this exercise is given in the growing season, take the students into a fruit plantation.

II. Starting a Small Fruit Plantation.

Material needed.—Twelve sets black-cap raspberry layers; six black-cap raspberry sets one year transplanted; six blackberry sets from root cuttings; six blackberry sets from sprouts; six currant plants two years old; six gooseberry plants two years old; six strawberry plants with black roots; twelve strawberry plants with white roots, indicating that they are the new growth; one spade and a small piece of land or one or more boxes of loam. If the box method is used, they should each be at least 4 feet square and 8 inches deep and should be filled full of good garden loam just moist enough to work well.

Exercise.—Have the students describe how blackberry, raspberry, currant, and gooseberry sets are grown, including the date and method of performing each operation. Select a different student for each kind of fruit. Select also a student to show the kind of plants produced by dividing the black-cap and red raspberry plants; discuss the merits of each and also the difference between one year and two year old strawberry plants.

III. Diseases of Small Fruits.

Material needed.—A growing small fruit plantation containing several varieties. This lesson should be given in late summer or early autumn.

Exercise.—Visit small fruit plantations with the students and call attention to the diseases present in the different classes of plants. Have the students take notes and make drawings of the injuries done. Also take notes of the effect of the diseases upon the plants, and of the varieties that are most nearly exempt. Look specially for anthracnose on raspberries, leaf spot on currants and gooseberries, and rust spot on strawberry leaves. Also, if several varieties of strawberries are at hand, have the students estimate the relative injury from disease done to the different varieties.

FIFTEENTH LECTURE—STRAWBERRIES.

Origin.—The chief varieties of the cultivated strawberry are included in the following species:

(a) Chilestrawberry (*Fragaria chiloensis*). This enters very largely into our cultivated kinds.

(b) American strawberry (*Fragaria virginiana*) enters in a small way into the parentage of some of our cultivated kinds.

(c) The Alpine strawberry (*Fragaria vesca*) is the parent of some of the so-called everbearing strawberries, but these are of little importance in a commercial way. A nearly allied or perhaps the same species is found in the northern part of the United States.

Propagation.—(a) By runners which are produced in abundance by most kinds and are generally taken off in the spring.

(b) Runners may also be taken off before the plants have roots and be rooted in a propagating bench.

(c) Runners are sometimes rooted in pots set under them in the ground and removed as soon as well rooted.

(d) New varieties are obtained from seed.

Soils and location.—Strawberries will grow on any land good enough to produce corn.

Plants.—(a) Plants for starting a new bed should never have fruited. Plants of the first-class have white roots, while old plants have black, wiry roots.

(b) Some plants, the pistillate kinds, bear flowers that are lacking in pollen. These are often exceedingly productive, if properly pollenized. The Crescent and Warfield are of this variety. Other plants have perfect flowers, such as the Beder Wood, Splendid, and Senator Dunlap.

(c) In planting, the pistillate sorts should constitute about two-thirds of the whole; the other third should consist of perfect flowering varieties.

Planting.—(a) For general use in the North, set out the plants in the spring after they have made a slight growth. Plantings may also be made in the latter part of the summer or even late in autumn if the conditions for transplanting are good. In the South it is customary to set the plants in the autumn, as they will then fruit the next spring. Plants for this purpose may be obtained from the North.

(b) The soil should be prepared as carefully as for a first-class crop of corn and be manured as heavily.

(c) The plants should be set at the same depth at which they grew in the nursery; spread the roots.

(d) Plants should be set out 2 by 4 or 3 by 4 feet, according to their vigor and habits of growing.

(e) They may be set out by means of the flat dibber, by spade, or in furrows made with a small plow. Large growers generally use a transplanting machine.

(f) Late autumn plantings may be covered with a few inches of soil which should be removed in the spring. A rake is the best implement for this purpose.

(g) Strawberries may be grown in hills, in which case all runners should be removed.

(h) They are also grown in hedgerow form. A compact row is formed and then all side runners are kept removed.

(i) They are also grown by spreading the runners over a space about 2 feet wide, called the matted-row system.

Cultivation.—The soil should be kept loose throughout the whole season and if practicable should be cultivated at least once in the spring of the second year. It will be necessary to remove the mulch and then replace it in order to do this, but the extra labor will be fully repaid, for the mulch and cultivation are specially important in the case of clay soils, which are apt to bake, or when land is disposed to weeds.

Protection.—Protection in some sections is given merely to prevent alternate freezing and thawing in winter. A very light covering, about 4 inches of mulch, is all that is required. In the northwestern prairie States it is desirable to mulch at least 6 or 8 inches deep to insure against winterkilling. As there is plenty of straw in that section the covering is not expensive.

The best mulch is some strawy matter, like pine needles, sedge hay, sorghum bagasse, cornstalks, etc., which have no weeds in them. Straw of various kinds is used, and even hay, but it is often troublesome on account of the grain and grass seeds in it, which seed down the land. The mulch may be removed in the spring as soon as danger of severe freezing is past. If removed early the plants will flower early or they may be kept back by leaving the mulch on late, but it must be removed as soon as the plants start into growth. Mulch is used in the spring and summer between the plants to keep the fruit from getting dirty and to hold moisture. The flowers may be protected on frosty nights in the spring by covering with mulch. This should not be allowed to remain on them for more than a day or two at a time.

Age of strawberry beds.—(a) Plants bear fruit the season following planting.

(b) In the North, strawberry beds after fruiting may be renewed by mowing, burning, and thinning out. They may last several years when thus treated. Many growers in the North prefer growing but one crop of fruit from a strawberry bed. This is the uniform practice in the South.

Fruit.—(a) The strawberry varies much in color, from white to pink and a deep dark red, and in form from regular conical berries to berries that are cockseomblike. Some varieties of berries are soft and only valuable for the local market, while others are firm and may be shipped long distances.

(b) Strawberry growing in the South differs materially from that in the North. Since strawberries do not thrive well during the heat of the southern summer, plants are usually obtained in the North and set out in autumn to fruit the next spring.

(c) Strawberries are sometimes grown in winter in greenhouses.

Insects and diseases.—Common insects of the strawberry are the leaf roller, white grub, and curculio. Leaf spot is the most common disease. (References No. 57, pp. 9-20; No. 4, pp. 153-169; No. 29, pp. 165-172; No. 19.)

EXPERIMENT AND PRACTICE WORK—FIFTEENTH LECTURE.

I. Vigor of Strawberry Plants.

Material needed.—Access to a strawberry bed containing several varieties; material for taking notes.

Exercise.—Have each student count the number of runners produced by each kind. From the average number of runners thus obtained make a table showing the number of runners produced by each variety.

II. Varieties of Small Fruits.

Material needed.—Material for taking notes and blank maps of North America.

Exercise.—Make drawings of the districts of North America where each of the small fruits mentioned are grown. These districts can all be put on one map by using pencils of several colors. On each district indicate the varieties most favorably recommended by the American Pomological Society, and then note the kinds that occur in the largest number of districts.

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33. Florida Fruits, by Helen Harcourt. Louisville, Ky., J. P. Morton & Co., 1886.
34. Soils and Fertilizers, by H. Snyder. Easton, Pa., Chemical Publishing Co., 1905.
35. Plant Food Constituents used by Bearing Fruit Trees. New York State Experiment Station Bul. 265.
36. Field Operations of the Bureau of Soils, U. S. Dept. Agr.—1900, p. 173, Soil Survey of Kent County, Md., by J. A. Bonsteel; 1901, p. 75, Soil Survey of the Westfield Area, New York, by R. T. Avon Burke and H. W. Marean; p. 559, Soil Survey of the San Gabriel Area, California, by J. G. Holmes and L. Mesmer; 1902, p. 143, Soil Survey of the Lyons Area, New York, by W. E. Hearn; p. 187, Soil Survey of the Albemarle Area, Virginia, by C. N. Mooney and F. E. Bonsteel; p. 491, Soil Survey of Clinton County, Ill., by J. A. Bonsteel et al.; p. 533, Soil Survey of Clay County, Ill., by G. N. Coffey et al.; p. 593, Soil Survey of Howell County, Mo., by E. O. Fippin and J. L. Burgess; 1904, p. 143, Soil Survey of the Dover Area, Delaware, by F. E. Bonsteel and O. L. Ayrs; p. 317, Soil Survey of the Fort Valley Area, Georgia, by W. G. Smith and W. T. Carter, jr.; p. 1183, Soil Survey of the San José Area, California, by M. H. Lapham; p. 1263, Soil Survey of the Los Angeles Area, California, by L. Mesmer; 1905, p. 95, Soil Survey of the Auburn Area, New York, by J. E. Lapham and H. H. Bennett; p. 845, Soil Survey of Webster County, Mo., by J. A. Drake and A. T. Strahorn; p. 1115, Soil Survey of the San Bernardino Valley, California, by J. G. Holmes et al. (Separate reports of these soil surveys with maps may be obtained by applying to the Secretary of Agriculture, Washington, D. C., or to a Senator or Representative in Congress.)
37. Orchard Culture. Ohio Experiment Station, Bul. 171.
38. Peach Growing for Market. U. S. Dept. Agr., Farmers' Bul. 33.
39. Commercial Fertilizers. U. S. Dept. Agr., Farmers' Bul. 44.
40. Marketing Farm Produce. U. S. Dept. Agr., Farmers' Bul. 62.
41. Insect Enemies of the Grape. U. S. Dept. Agr., Farmers' Bul. 70.
42. The Peach Twig-borer. U. S. Dept. Agr., Farmers' Bul. 80.
43. Notes on Frost. U. S. Dept. Agr., Farmers' Bul. 104.
44. The Apple and How to Grow It. U. S. Dept. Agr., Farmers' Bul. 113.
45. Irrigation in Fruit Growing. U. S. Dept. Agr., Farmers' Bul. 116.
46. Grape Growing in the South. U. S. Dept. Agr., Farmers' Bul. 118.
47. Orchard Enemies in the Pacific Northwest. U. S. Dept. Agr., Farmers' Bul. 153.
48. The Home Fruit Garden: Preparation and Care. U. S. Dept. Agr., Farmers' Bul. 154.
49. The Home Vineyard. U. S. Dept. Agr., Farmers' Bul. 156.
50. The Propagation of Plants. U. S. Dept. Agr., Farmers' Bul. 157.
51. Practical Suggestions for Fruit Growers. U. S. Dept. Agr., Farmers' Bul. 161.
52. Home Manufacture and Use of Unfermented Grape Juice. U. S. Dept. Agr., Farmers' Bul. 175.
53. Cranberry Culture. U. S. Dept. Agr., Farmers' Bul. 176.
54. Insects Injurious in Cranberry Culture. U. S. Dept. Agr., Farmers' Bul. 178.
55. Pruning. U. S. Dept. Agr., Farmers' Bul. 181.
56. Barnyard Manure. U. S. Dept. Agr., Farmers' Bul. 192.
57. Strawberries. U. S. Dept. Agr., Farmers' Bul. 198.
58. Canned Fruits, Preserves, and Jellies. U. S. Dept. Agr., Farmers' Bul. 203.

59. Varieties of Fruits Recommended for Planting. U. S. Dept. Agr., Farmers' Bul. 208.
60. Raspberries. U. S. Dept. Agr., Farmers' Bul. 213.
61. Fungicides and their Use in Preventing Diseases of Fruits. U. S. Dept. Agr., Farmers' Bul. 243.
62. Important Insecticides. U. S. Dept. Agr., Farmers' Bul. 127.
63. Insecticides and Fungicides. U. S. Dept. Agr., Farmers' Bul. 146.
64. Text Book of the Physics of Agriculture, by F. H. King. Madison, Wis., Author, 1901.
65. Cold Storage with Reference to the Pear and Peach. U. S. Dept. Agr., Bureau of Plant Industry Bul. 40.
66. The Apple in Cold Storage. U. S. Dept. Agr., Bureau of Plant Industry Bul. 48.
67. Apple Orchard Surveys of Wayne and Orleans Counties, New York. New York Cornell Experiment Station Buls. 226 and 229.

LIST OF APPARATUS AND MATERIAL.

[Retail prices.]

1 compound microscope with $\frac{1}{4}$ -inch objective.....	\$30.00
12 slides.....	.60
12 cover glasses.....	.20
1 Coddington lens.....	1.75
6 mounted slides.....	1.50
8 Brendel models.....	25.00
6 ordinary thermometers.....	1.50
6 good thermometers.....	2.00
3 self-registering thermometers (maximum).....	18.00
3 self-registering thermometers (minimum).....	18.00
1 map of North America.....	.50
25 maps of the State.....	1.25
1 chart showing cuttings.....	1.50
1 chart showing layering.....	1.50
1 chart showing grafting.....	1.50
1 chart showing budding.....	1.50
1 diagram of fruit-storing quarters.....	.50
1 pair balances.....	40.00
1 No. 12 scale.....	6.00
2 cases of life histories of common insects.....	5.00
8 charts of life histories of common insects.....	3.00
1 psychrometer.....	.75
1 small hand force pump.....	5.00
1 Bordeaux nozzle.....	1.00
1 Vermorel nozzle.....	1.00
1 pair dust bellows.....	3.00
2 spades.....	1.50
1 shovel.....	.75
1 garden trowel.....	.20
1 hammer.....	.60
1 budding knife.....	.20
1 girdling knife.....	.20
1 knife.....	.50
1 grafting knife.....	.20
1 pair pruning shears.....	2.00
7 1-quart Mason jars.....	.35
4 2-quart Mason jars.....	.30
6 specimen jars.....	.60
25 4-ounce screw-cap jars.....	.25
6 large plain glass tumblers.....	.24
4 Argand lamp chimneys.....	.24
50 feet of measuring tape.....	1.00
1 ball of twine.....	.50

3 square feet of burlap.....	\$0.05
4 pieces of cheese cloth 8 inches square	.05
2 dozen sheets of heavy manila paper	.20
1 piece rosin-sized builder's paper.....	.05
8 yards of brown wrapping paper.....	.15
1 1-pound bundle of raffia	.20
2 yards cotton cloth.....	.10
25 pencils.....	.25
25 rulers.....	.50
25 violet aniline pencils No. 2.....	1.25
25 sheets of paper 5 by 7 inches.....	.25
1 paper of pins.....	.05
20 1-pound paper bags.....	.25
2 copper or brass 8-inch sieves, 1 and 2 millimeters mesh	.70
3 ½-bushel swing baskets.....	.30
1 oil barrel.....	1.00
2 12-quart kegs.....	.50
1 18-quart basket.....	.15
1 bushel box.....	.25
1 apple barrel.....	.40
1 16-quart crate (gift) and boxes.....	.20
1 6-quart crate.....	.10
1 pint box fruit crate.....	.15
1 quart box fruit crate.....	.20
12-box peach crate.....	.30
1 barrel press.....	2.00
3 glass tubes 2 inches in diameter and 18 inches long.....	.60
1 common baking tin, 2 inches deep.....	.10
1 frame, 6 feet square.....	.75
36 square feet wire screen.....	.60
1 lath screen.....	.25
1 box 6 by 6 inches square.....	.25
1 trellis for grapevine.....	.75
22 stout stakes, 2 feet long.....	.50
1 bucket whitewash.....	.10
4 pounds quicklime.....	.15
4 pounds sulphate of copper.....	.25
1 pound grafting wax.....	.30
1 pound tallow.....	.05
2 pounds beeswax.....	.25
4 pounds resin.....	.40
½ pint formaldehyde.....	.05
½ ounce carbolic acid.....	.05
1 pound Paris green.....	.50
1 pound whale-oil soap.....	.15
5 pounds tobacco stems.....	.10
1 pound arsenate of lead.....	.15
1 pound cheap flour.....	.05
1 pound pyrethrum powder.....	.40
3 pounds plasterer's hair.....	.30
1 pound barrel nails.....	.05
6 apples.....	.10
10 pounds nitrate of soda.....	.30
Total.....	198.28

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ON FARMERS' INSTITUTES.

BULLETINS.

- Bulletin No. 79.—Farmers' Institutes—History and Status in the United States and Canada. By L. H. Bailey. Pp. 34. 1900.
- Bulletin No. 110.—Proceedings of the Sixth Annual Meeting of the American Association of Farmers' Institute Workers, held at Buffalo, N. Y., September 18 and 19, 1901. Edited by A. C. True, D. J. Crosby, and G. C. Creelman. Pp. 55.
- Bulletin No. 120.—Proceedings of the Seventh Annual Meeting of the American Association of Farmers' Institute Workers, held at Washington, D. C., June 24-26, 1902. Edited by A. C. True and D. J. Crosby for the Office of Experiment Stations and G. C. Creelman for the Association. Pp. 119.
- Bulletin No. 135 (Revised).—Legislation Relating to Farmers' Institutes in the United States. By John Hamilton, Farmers' Institute Specialist. Pp. 35. 1905.
- Bulletin No. 138.—Proceedings of the Eighth Annual Meeting of the American Association of Farmers' Institute Workers, held at Toronto, Ontario, June 23-26, 1903. Edited by W. H. Beal for the Office of Experiment Stations and G. C. Creelman for the Association. Pp. 119.
- Bulletin No. 154.—Proceedings of the Ninth Annual Meeting of the American Association of Farmers' Institute Workers, held at St. Louis, Mo., October 18-20, 1904. Edited by W. H. Beal and John Hamilton for the Office of Experiment Stations and G. C. Creelman for the Association. Pp. 91.
- Bulletin No. 155.—Agricultural Instruction for Adults in the British Empire. By John Hamilton. Pp. 96. 1905.
- Bulletin No. 163.—Agricultural Instruction for Adults in Continental Countries. By John Hamilton. Pp. 32. 1905.
- Bulletin No. 165.—Proceedings of the Tenth Annual Meeting of the American Association of Farmers' Institute Workers, held at Washington, D. C., November 9-11, 1905. Edited by W. H. Beal and John Hamilton for the Office of Experiment Stations and G. C. Creelman for the Association. Pp. 95.
- Bulletin No. 166.—Course in Cheese Making for Movable Schools of Agriculture. By L. L. Van Slyke. Pp. 63. 1906.
- Bulletin No. 174.—History of Farmers' Institutes in the United States. By John Hamilton. Pp. 96. 1906.
- Bulletin No. 182.—Proceedings of the Eleventh Annual Meeting of the American Association of Farmers' Institute Workers, held at Baton Rouge, La., November 12-14, 1906. Edited by W. H. Beal for the Office of Experiment Stations and John Hamilton for the Association. Pp. 90.

CIRCULAR.

- Circular No. 51 (Revised).—List of State Directors of Farmers' Institutes and Institute Lecturers of the United States. By John Hamilton. Pp. 32. 1906.

SEPARATES.

- Farmers' Institutes in the United States. By D. J. Crosby. Reprint from Annual Report of the Office of Experiment Stations for the year ended June 30, 1902. Pp. 25.
- Farmers' Institutes in the United States. By John Hamilton. Reprint from Annual Report of the Office of Experiment Stations for the year ended June 30, 1903. Pp. 57.
- Farmers' Institutes. By John Hamilton. Reprint from Yearbook, Department of Agriculture, 1903. Pp. 10.
- Annual Report of Farmers' Institutes. By John Hamilton. Reprint from Annual Report of the Office of Experiment Stations for the year ended June 30, 1904. Pp. 58.
- Farmers' Institutes in the United States. By John Hamilton. Doc. No. 711. Pp. 20. A pamphlet prepared for distribution at the Louisiana Purchase Exposition.

LECTURES.

- Farmers' Institute Lecture No. 1. Syllabus of Illustrated Lecture on the Care of Milk, accompanied with 44 lantern slides. By R. A. Pearson. Pp. 12. 1904.
- Farmers' Institute Lecture No. 2. Syllabus of Illustrated Lecture on Potato Diseases and their Treatment, accompanied with 47 lantern slides. By F. C. Stewart and H. J. Eustace. Pp. 30. 1904.
- Farmers' Institute Lecture No. 3. Syllabus of Illustrated Lecture on Acid Soils, accompanied with 53 lantern slides. By H. J. Wheeler. Pp. 28. 1904.
- Farmers' Institute Lecture No. 4. Syllabus of Illustrated Lecture on Profitable Cattle Feeding, accompanied with 45 lantern slides. By F. B. Mumford. Pp. 21. 1905.
- Farmers' Institute Lecture No. 5. Syllabus of Illustrated Lecture on Silage and Silo Construction for the South, accompanied with 50 lantern slides. By A. M. Soule. Pp. 31. 1905.
- Farmers' Institute Lecture No. 6. Syllabus of Illustrated Lecture on Essentials of Successful Field Experimentation, accompanied with 32 lantern slides. By C. E. Thorne. Pp. 24. 1905.

